MACHINERY.

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THE VERTICAL MILLING MACHINE.

John Becker.

THOSE not familiar with the most modern machines usually associate a vertical milling machine with an ordinary drill press, using a butt or end mill instead of a drill. While a good drill press is admirably adapted to its work, it is designed for a very different class of work, and most of the strains to which it is subjected to while drilling are torsion of spindle, end thrust caused by drill entering work, and spring of table or knee, also due to same cause. These can be met by making the spindle large enough to withstand the torsion and providing ample thrust bearings and supports.

The milling machine has another serious strain to meet and overcome, namely, the side strain due to the work being fed against the sides of the cutter, as in milling slots and in nearly all milling work. This demands that the spindle shall be kept in alignment and must be perfectly free from one-sided action due to belt or other driving power. Back gears should be made double so as to equalize and balance their action and the strain on the spindle, and the alignment must be maintained perfectly square (or perpendicular) with the table or platen. A large class of work demands a high spindle speed for small cutters, as will be seen by the data given below. In addition to the traversing table a rotating table will allow a much larger variety of work to be done, such as circular slots, segments, etc.

When the spindle is vertically adjustable it allows quick adjustment of the cutter and greatly facilitates the work. Many do not appreciate the value of end or butt milling, and seem to think that a horizontal mill is necessary for surfacing work, but a few experiments will show the fallacy of this idea, especially in surfacing work where the surface being milled greatly varies as in the casings shown in Fig. 1 (next page). These present a long surface to the mill at the start, as will be seen, and after cutting this "bar" it comes to the two or three thin bars, as the case may be, and having so much less metal to remove, the cutter is relieved from the upward pressure due to the heavy work, and returns to its normal position, which cuts the thin partitions a trifle lower than the front edge. This continues till the next long cut is reached and the cutter raises again; it must not be supposed that this raising is visible to the eye, it may be only half a hundredth of an inch, but it's there, and a straight edge will prove it. True, this can be avoided in a measure in this case by setting the piece at an angle, making the work of the cutter nearly even, but if there are any channels, as is often the case, it cannot be avoided with a horizontal mill. The dotted lines in Fig. 2 show how this is done with a vertical mill and how the tendency is for more even surfacing. The upward thrust is easily taken care of by a good thrust-bearing, and the mill itself is not liable to spring unless of very large diameter.

There are a few jobs that a horizontal machine can do which cannot be quite as readily done on the vertical, but there are many which can only be done to advantage on the vertical machine, and much work that is now done on a planer or lathe can be done better and cheaper on a vertical machine.

With a spindle capable of running at high speed, small cutters can be made very useful, which on the ordinary machine would be worthless. Right here the writer will mention an experience he had on a job which consisted of the milling of 1,400 slots in hard bronze, the size of the slot being one-half inch in depth, width about one-sixteenth inch, and length of the cut from two to three inches. This required a very slender and delicate cutter, as will be readily understood. In the machine used, a speed of 7,000 revolutions per minute was determined upon. At this speed it was found that the mill would last just about long enough to mill twelve slots, and would invariably break off at the neck. While this result was entirely satisfactory, yet it was decided to experiment at a speed of about 14,000 revolutions of the spindle to see if the cutter would average a greater number of cuts before giving out. The result was that while at 7,000 revolutions per minute the cutter would make an average of twelve cuts, at double the speed the balance of 1,333 cuts that remained to be made averaged fifty cuts to the cutter before breaking. The case mentioned was an unusual one, but it illustrates the advantage of a milling machine capable of high spindle speed without overheating bearings. In a machine where the greatest speed obtainable is, say, about 700 revolutions, cutters from one-eighth to three-eighths inches diameter are used at same spindle speed, whereas the speed upon soft iron or steel for a cutter one-eighth inch diameter should be about 2,000 revolutions per minute. Yet how many shops have milling machines capable of such speed? Very few indeed, comparatively speaking.

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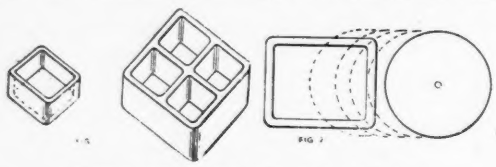
AN ENGINEER'S EDUCATION,—2.

W. H. Wakeman.

The claim that if all were educated then all would have an equal chance, follows this as a natural consequence, and it is probably a just claim to make. If all men were rich, then all would have equal power so far as money is concerned, but this does not seem to prevent any of us from securing all of the wealth that may come to us honestly. The broad claim that complete education in steam engineering matters is of no value

is frequently made, but the best reply that can be made to this assertion is to inquire into the character and standing of the men who make it, and having heard it advanced a great many times I do not hesitate to state that I have never heard a thoroughly educated man make it seriously. Who are best qualified to judge in such matters, those who have tried it or those who have not? If we want to get a reliable opinion of the value of a certain kind of engine, and go about it in the right way, we will seek several men each of whom have had charge of one of that particular kind long enough to become thoroughly conversant with all of its good and bad qualities, and then judge accordingly. Admitting this to be proper, then why do we place any confidence in the statement that education is of no value, when it is made by men who have never tried it, and therefore are not qualified to judge? Just imagine the inconsistency of listening to an engineer who claims that in calculating the duty of a pumping engine, foot



VERTICAL MILLING MACHINE.—SEE FIRST PAGE.

pound and heat units are of no account whatever, but all that is required to know is the number of gallons pumped into the reservoir in a day, and then placing any value on his opinion of education in steam and hydraulic engineering. Could anything be more ludicrous than this? If an engineer can hold his position without this knowledge, I am sure that no objections will be raised here, but when he utterly condemns it as of no use to any one, it is time to enter a protest. Whatever may be our private opinion as engineers, there is one thing that we must admit if we are candid, and that is that more theoretical knowledge is required of those who would hold responsible positions now than was formerly, and this being the case the less time we spend in combating the idea, and the more time we spend in preparing for the inevitable, the better it will be for us in every way.

Sometimes a man who is thoroughly educated in practical and theoretical steam engineering, is employed to run a large plant. The first month his mind is filled with ideas concerning ways in which the plant may be improved in appearance, and the cost of operating it reduced without lowering the wages of the assistant or the firemen. If you are well acquainted with him he will tell you what it is that causes the main engine to pound, and why it is that the next largest engine needs so much repairing from time to time. You will also know that the plant requires more fuel than it should, and will also be informed that a cheaper grade of coal could be used with profit, and numerous small plans will be talked up whereby the tone of the whole plant may be improved.

Time passes away and in a year or so you call again, and are surprised to find that there has been but little improvement made there, except that the place is cleaner and there are no leaky joints in steam or water pipes, as formerly, the brick-work is whitewashed and in short many small improvements are apparent, but no large ones have been made. On inquiry as to the cause of it, you discover that the main engine has been run for many years since the cylinder was bored out, and as it is larger at the ends than in the middle, the pound cannot be stopped. The engineer has reported it to the proprietor, who in turn has inquired concerning the cost of reboring it, but as no one cares to do it as a compliment, the engineer is told that he must get along with it as it is. The second engine is shut down for repairs, and when you are informed that it is because it is overloaded while another engine is running with a very light load, and that it would be but comparatively a small job to even this load between them, while the proprietor declines to have it done because he cannot see the necessity of it, you begin to understand the indifference of the engineer in charge.

The coal bills are nearly as large as formerly, because a condenser has not been added to the main engine, although there is an abundance of water on the premises with which to supply the apparatus. Egg coal is still used, although it has been fully demonstrated by actual trial that pea coal is much cheaper, but because it makes more ashes than the larger grades of coal, the plan for using it is abandoned There are many grades of coal in the market, the price of which varies much, but this chief engineer does not claim to know just which is the most economical. It is true that he could give a shrewd guess just as many others are doing, but he wants to know beyond a doubt that his conclusions are correct before he reports them, and so he has made a request that he be allowed to fit up one boiler so as to give the different grades of coal a fair trial, but as this will cost $50.00 the superintendent concludes that it cannot be afforded, and the matter is dropped. The natural result of all this is to discourage the engineer and make him resolve to get along with it as best he can, for if those who must pay the bills do not care, then why should he worry about it?

If some brother engineer calls his attention to some of these things, and he replies that "The company is rich, they can stand it," let us be careful not to censure him too strongly for his lack of interest in his employer's affairs, for this is always the way that it appears to others.

If steam users and superintendents would strive to encourage their engineers to work for their interests, there would be more of it done without doubt, and a better feeling would prevail. Trade literature is not to be dispised at this day and time, but the running engineer cannot always afford to pay for as much of it as he would like to, while many samples of our best publications are sent freely to the office, from whence they are sometimes thrown away with the wrappers still on them. Would it not be well to place this reading matter at the disposal of the engineer by way of encouragement? Would it not be well to occasionally present him with some good book treating of matters that interest him?

We have known of superintendents who were so ignorant of he composition of what is known as human nature, and so lacking in that somewhat uncommon commodity, namely, common sense, as to decline to place the management of the details of running the plant in the hands of their engineer, but who wish to usurp his place altogether, except in doing the laboring part of the work.

Think of the absurdity of a superintendent telling his engineer that he must consult him before he cleans his boilers, and dictating as to the number of drops of cylinder oil that shall be used per minute. If an engineer is expected to take a healthy interest in his plant, he must have some of the responsibilities placed upon him and be made to feel that he will receive full credit for all improvements made, and will be held responsible for blunders that he makes. Nothing is more disgusting to a faithful engineer than to institute some changes in the design of the plant, or in its mode of operation, perhaps against the advice of the superintendent, and after it has been proven a success, to have said superintendent come around, and when showing it to visitors, claim all of the credit for making the necessary changes.

As a rule, superintendents of factories have abundant opportunities to show what they can do in the way of managing men and improving methods, without encroaching on the comparatively small sphere of the engineer, and robbing him of the proper credit due him for honest work. The plea is sometimes made that the engineer is not capable of taking the full responsibility of running his plant, but I should like to inquire how this point has been determined? Certainly not by actual experiment, and I know of no other way of arriving at a well founded conclusion, either for or against the plan. If any reader of this has been running his plant in this way, I propose that a conference be held with the engineer, that he be told fairly and squarely that henceforth he is to be responsible for the safe and economical operation of the plant, and that to this end all necessary appliances will be furnished. After the matter has been fully understood, if he does not rise to meet the new conditions, and appreciate the honor conferred on him, then there is but one remedy, and that is to give some other superintendent, in another place, a chance to develop his latent ambition. This plan is not unfair, if properly carried out, but is for the best interests of all concerned.

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STRENGTH OF HYDRAULIC CYLINDERS.

Having an inquiry from a maker of hydraulic jacks concerning the proper thickness for the walls where a 12-inch ram was to sustain 350 tons, we secured the information given below from men who are well known in this and other lines of work:

"We have yours of the 2d, and are well aware that there is a vast amount of difference in the practice of designing the thickness of the walls for hydraulic cylinders. The trouble is that

parties attempt to cure a bad casting or improper material by putting in more of the same stock, without in any way strengthening it. Where the cylinder is a plain cylinder, subject to no strains at all except the bursting strains, it is all that would be necessary to make the walls heavy enough to withstand the working pressure per square inch, multiplied by the interior diameter, plus about 10 per cent. for the end strain. This is based on there being no beam action of any kind upon the cylinder, but on account of water hammer which frequently occurs in hydraulic presses, it is well that the factor of safety be a pretty good one. Our rule is here that we do not strain much over one-third the elastic limit. As you are probably aware, there are quite a number of points which have to be taken into consideration in the designing of a cylinder, and we would not advise a person who is not in the habit of doing it to undertake it.

THE WATSON-STILLMAN CO., F. H. STILLMAN.
NEW YORK, June 3, 1896.

"In the case mentioned we have

$$\frac{350 \text{ tons} \times 2\,000 \text{ (lbs.)}}{\text{The area of 12-inch ram}} = \frac{700\,000}{113} = 6\,200$$

pounds per square inch. Then with formula

$$t = \frac{P \times R}{S}$$

we have

$$t = \frac{6\,200 \times 7}{6\,000} = 7.23$$

inches thick for cylinder if of good tough and soft cast iron. I have taken the radius as 7 inches, because it would be used to give the plunger clearance below the bearing, and I have assumed 6 000 pounds as the safe tensile strain to which the material referred to will bear, as I have proved by experience and which is noted in my article.*

"I would, however, advise the use of steel for the cylinder and have it made without projection, lugs or flanges, so as to get a homogeneous casting, and then comes the matter of safe tensile strain. I have before me the Standard Steel Casting Co.'s book and find it rated as having an ultimate tensile strength of 63 000 pounds and an elastic limit of 38 217 pounds per square inch. One-fifth of 63 000 = 12 600, which equals one-third of the elastic limit, and is certainly safe in every way. Then we have

$$t = \frac{6\,200 \times 7}{12\,600} = 3.44$$

inches thick. I have no doubt this material would be safe under one-half the elastic limit, or 18 000 pounds per square inch would give a thickness of 2.41 inches, or one-third of that of cast iron, as in the first case. JOHN H. COOPER.
PHILADELPHIA, PA.

In reference to the inquiry concerning large hydraulic jacks, there is not so much known as is desirable about the strength of thick cast iron cylinders exposed to high internal pressures. Some years since the attempt was made to launch the British vessel *Leviathan*, in which attempt hydraulic presses were employed. The rams of these presses were 10 inches diameter and the metal in the cylinder walls was 7½ inches. These cylinders failed at a pressure of less than five tons per square inch (long tons.) It is known, however, that increasing the thickness of such a cylinder beyond some point not very definitely settled, does not add to its strength for the purpose for which it is used, at least we are told so on what appears to be good authority, and the statement looks reasonable.

Barlow's formula for the thickness of such cylinders is

$$T = \frac{R \times P}{S - P}$$

in which T=the thickness of metal in inches, R=radius of the inside diameter of cylinder, P=the pressure per square inch employed, and S=the cohesive strength of the metal per square inch, which may be taken as 18 000 pounds. This would give the disrupting pressure. It will be seen that a high factor of safety cannot be adopted, nor is one required if sure about the casting. Instead of 18 000, 9 000 may be used, for safety.

In the instance cited:

$$R = 6 \text{ inches, } P = \frac{350 \times 2\,000}{113} = 6\,195 \text{ pounds.}$$

It is assumed that net tons are referred to; 113 inches is the area of the ram.

By substituting numerical values in the formula we have:

$$T = \frac{6 \times 6\,195}{9\,000 - 6\,195} = 13.25 \text{ inches}$$

(13¼ inches) of the thickness of metal.

To put it in the form of a rule we may say: *Multiply the inside radius of the cylinder by the pressure per square inch and call the product* a; *subtract the pressure in pounds per square inch from the fraction of the disruptive pressure to which it is safe to submit the cylinder, and call the remainder* b. *Divide* a *by* b *and the quotient will be the thickness, in inches, of the walls of the cylinder.*

Referring again to the failure of the presses employed for launching the *Leviathan*, Barlow's absolute disruptive pressure would be:

$$P = \frac{S \times T}{R + T}$$

Substituting numericals, and letting S=18 000 instead of 9 000, we have:

$$P = \frac{18\,000 \times 7\frac{1}{2}}{5 + 7\frac{1}{2}} = 4.8 + \text{ long tons.}$$

The cylinders of the presses broke at a little less than five tons, which is just what we should expect. F. F. HEMENWAY.

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RULE FOR SAFE AND BURSTING STRAINS OF TUBES, PIPES AND HOLLOW CYLINDERS.

JOHN H. COOPER.

The simplest rule that can be written for ascertaining the thickness of the walls of pipes, tubes and hollow cylinders to resist internal pressure, is the following:

$$t = \frac{PR}{S} \quad (1.)$$

In this formula,

t=thickness of material in the walls of the tube.
R=internal radius of the tube.
P=internal pressure in pounds per square inch.
S=tensile strain in pounds per square inch to which the material is subjected by the pressure P.

This form of rule has the sanction of Bernoulli, Unwin, Rankine, Clandel, Weisbach and Clarke, and with modifications for special uses by Reuleaux, Brix, Barlow, Lame, Grashof, Trautwine and Clark, but as the rule of each leads to so nearly the same result, for general purposes, what is given above may be accepted as the foundation rule which must not be departed from in any case, to which, however, certain elements may be added in order to cover particular cases, a few of which will be named.

This formula is used for ascertaining the thickness of boiler shells, for resisting internal pressure, by all the boiler inspection companies, but into it is inserted the *factor of safety* and the comparative strength of the riveted joints to the solid plates, which are of course limiting elements.

The formula for the thickness of the shell is:

$$t = \frac{PRF}{S\text{ (A or B)}} \quad (2.)$$

In which—

F=the factor of safety, usually taken as 5.
A=the strength of the punched plates.
B=the strength of the driven rivets; the least of these to be taken, because the safe strength of any structure cannot be above the strength of its weakest part.

It should be noticed that the element S may be inserted in formula (1) as the ultimate tensile strength of the material, when you wish to find out the pressure P that will burst the tube, or S may represent $\frac{1}{4}$, $\frac{1}{8}$, or $\frac{1}{10}$ of the ultimate strength, in place of F, according to the degree of safety required. For weldless tubes the elements A and B must be omitted.

Having now at hand the essential elements of the rule as a safe foundation to build upon, we are prepared for the modifications of the rule to suit particular cases. The factor of safety must be well looked after in order to insure safety, experience proving

* Next column.

that it must change with every material and many times for the kind of service to which the material is subjected. As for instance, with the teeth of cast iron wheels: F may be 4 when the wheels are turned by hand; but F should be 16 when they are turned by power and subjected to the trying ordeal of rapid velocities and sudden reversals of motion.

A rather extraordinary case of rupture was that of an hydraulic cylinder which came under my notice many years ago. Its walls were 8 inches thick, the ram was 15 inches diameter, the internal diameter of the cylinder was 16 inches, the pressure about 6 000 pounds per square inch. By transposing the formula to find S, we have:

$$S = \frac{P R}{t} = \frac{6\,000 \times 8}{8} = 6\,000$$

that is, the tensile strain to which the metal in the cylinder was subjected was 6 000 pounds per square inch, which proved sufficient to completely rupture this cylinder; it went to pieces with a loud report. This casting was made of the strongest iron, it was melted in an air furnace, such as used for rolling-mill rolls, and was most carefully made in every particular. This cylinder was replaced by a new one of same dimensions, but of softer quality, having less tensile strength, but more elasticity.

In this case the material must have suffered from the effects of internal strains, the result of unequal cooling. It is well known that the metal at the centre of a mass of cast iron is weaker than the metal lying near its surface, with 8 inches of thickness, and metal of hard, "tight" quality there is ample room for the unequal strains.

Cast iron boiler heads of say 1½ to 2 inches thick, when the flanged part is turned at a sharp angle with the head, are known to be cracked by shrinkage nearly half way through from the internal angle. This character of rupture has proved the incipient cause of more than one boiler explosion.

Imperfect "lap" and "but" welds of tubes and inherent defects of any kind cause failure, unless covered by the factor of safety; but we must always remember that for imperfect materials and workmanship there is no certain rule.

In order to secure the largest margin of safety in the use of commercial material, the factor F is determined by experience with different materials and constructions. It is safest, therefore, to not go too near the rated ultimate strength, for fear of these hidden defects, and to make calculation safe, many authorities figure certain elements in their formulas in order to provide for the consequences of welding, casting, cooling, abnormal strains and other.

I think it best always to present rules in their simplest forms, clearly stating all the elements which make them up and to state clearly in what manner and to what extent they affect results; there is then no dread or danger of the existence of an unknown quantity in the rules.

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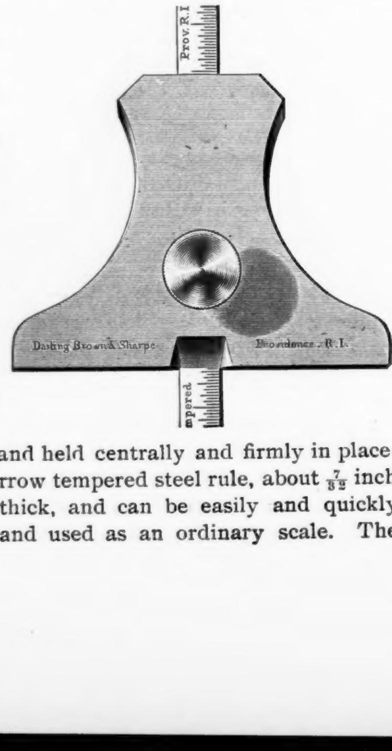
DEPTH GAUGE.

The depth gauge shown has been designed by Darling, Brown & Sharpe, Providence, R. I., with a view of furnishing a tool which is at once both durable and convenient. The head is a solid piece of steel, hardened, ⅛ inch thick and 2 inches long, of such form that it can be conveniently held while taking measurements. It is milled to receive the rule or blade, which slides in a slot in back of head. The front of the head is beveled back, as shown, to the width of the rule, thus greatly facilitating the reading of the graduations. The clamping device is made in such a manner that by tightening the screw shown on front of head the rule or blade is clamped upon both edges and held centrally and firmly in place.



The blade is a 6 inch narrow tempered steel rule, about $\frac{7}{32}$ inch wide and about $\frac{1}{20}$ inch thick, and can be easily and quickly detached from the head and used as an ordinary scale. The blade or rule furnished with the head is divided into 64ths on one side and 100ths inches on the other.

Catalogues and circulars mailed on application.

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THE FIRST PRINCIPLES OF MECHANICS.—9.

ENERGY.

LESTER G. FRENCH.

An agent is said to possess *energy* when it has the capacity of doing work—that is, of overcoming a resistance through a distance. In general, energy is something that is given to a body by doing work upon it, as when a weight is raised or is given a rapid motion, or when a spring is compressed, and that in turn is given out when the body itself performs work. Energy is therefore sometimes defined as stored work. It is expressed in foot-pounds, the same unit that is used to express work.

Energy is either *potential* or *kinetic*.

(*a*) Potential energy is the power of doing work possessed by a body in virtue of its position or condition. If a body be so situated that it is acted upon by a force which will produce motion in it upon the removal of some restraining force, it is said to have potential energy. Thus, a ball suspended by a string has the power of doing work, because, when the cord is cut, the ball will fall and will be capable of overcoming a resistance through a distance, the amount of the work depending upon the weight of the ball and the extent of the fall. A compressed spring and a head of water also have the capacity of doing work and are stored with potential energy.

The potential energy in any case is equal to the product of the force tending to produce motion, and the distance through which the body is able to move. If the suspended ball should weigh 10 pounds and hang 25 feet from the ground, it would possess 250 foot-pounds of energy. The force acting is here equal to the weight, or 10 pounds, and to raise the ball to its suspended position would require an expenditure of $10 \times 25 = 250$ foot-pounds of work, and when it falls it can give out just this amount of energy, which has been stored within it.

(*b*) Kinetic energy is the power of doing work possessed by a body in virtue of its motion. A moving railroad train, a fly-wheel, a current of air driving a wind-mill, a falling body, all possess kinetic energy. The kinetic energy of a body is obtained by multiplying one-half its mass by the square of its velocity in feet per second. Or,

$$E = \tfrac{1}{2} M v^2, \quad (15)$$

where E=energy in foot-pounds, M=mass and v=velocity in feet per second. The value of mass, we have already seen, is obtained by dividing the weight of a body by 32.16, the acceleration due to gravity, or

$$M = \frac{W}{32.16}$$

Hence we may write

$$\frac{W}{32.16}$$

in formula 15, giving

$$E = \tfrac{1}{2} \times \frac{W v^2}{32.16} = \frac{W v^2}{64.32} \quad (16)$$

It will be shown, shortly, how this formula is obtained.

CONSERVATION OF ENERGY.

Energy exists in various forms, such as mechanical, molecular and chemical. It is stored in all kinds of fuel, and is made apparent by chemical reactions, by muscular effort and by many other means. There is the potential energy of the electrical charge and the kinetic energy of the electrical current. Heat is a form of energy. In the present instance we are concerned with these different kinds, other than mechanical, only in that the universal and important law of the conservation of energy embraces them all. This law states, *1st. That energy may be transformed directly or indirectly from any one form to any other form, and 2d. That however energy may be transformed or dissipated, the total amount of energy must forever remain the same.* Energy can neither be created nor destroyed. *It simply exists,* and the various processes by which it is utilized are simply means for transforming it from one form to another. The steam engine changes heat energy into mechanical energy, and the percussion of a bullet against a rock converts mechanical into heat energy and melts the bullet. A body just at the point

of falling from an elevation has a store of potential energy. As it falls it loses potential energy, but its velocity increases and its potential energy is gradually changed into kinetic energy. This will be illustrated by an example.

Suppose a body weighing 100 pounds—a cannon ball, for example—to be so situated that it has no store of potential energy, and that it is shot vertically upwards with a velocity of 1 500 feet per second. From formula 16 we find its kinetic energy at the start to be

$$E = \frac{100 \times (1\,500)^2}{64.32} = 3\,498\,100 \text{ foot-pounds.}$$

This results from the potential, chemical energy of the gunpowder, part of which has gone to produce heat and sound. As the ball rises, it does work against gravity and also overcomes the frictional resistance of the air, the latter generating heat. When the ball is two miles high, its potential energy is equal to $100 \times 2 \times 5\,280 = 1\,056\,000$ foot-pounds, and neglecting the frictional loss, its remaining kinetic energy is $3\,498\,100 - 1\,056\,000 = 2\,442\,100$ foot-pounds. At the highest point reached the kinetic energy is entirely spent and the ball has its greatest store of potential energy. Could this be gathered together with the energy required for producing the heat and sound, it would exactly equal the amount of energy originally produced by the powder. As the ball drops to the earth again, its potential is changed back to kinetic energy, and when it reaches the ground it has the same velocity and hence the same amount of kinetic energy as when it left the gun, excepting the loss through friction.

We are now in a position to understand the derivation of formulas 15 and 16.

The potential energy of a body of weight W and at a height h is equal to W h, or

$$E = W\,h. \quad (17)$$

But, from the law of the conservation of energy the kinetic energy of the body in falling from the height h has the same value. Hence, formula 17 may be used for kinetic energy, provided an expression for velocity can be introduced into it. From formula 13 (last number) may be obtained the expression

$$h = \frac{v^2}{2\,g}$$

and writing this for h in (17), we get

$$E = W \times \frac{v^2}{2\,g} = \frac{W\,v^2}{64.32}$$

which is the same as before.

In examples involving the transformation of energy and its conversion into work, it should be remembered that work is done only when a resistance is overcome. A freely falling body is stored with energy, but it does no work until it meets with a resistance.

ROTATING BODIES.

When a body revolves about an axis, the particles at different distances from the center have different velocities, and hence different amounts of kinetic energy. For any such body, however, there is a mean radius of rotation, which is of such a length that if the whole mass of the body could be concentrated at the circumference of a circle having this radius, and rotated at the same speed as before, the same amount of kinetic energy would be developed. This mean radius is called the *radius of gyration.* For a solid, cylindrical body, like a disc or an emery-wheel, the radius of gyration is equal to the radius of the disc divided by $\sqrt{2}$. For a fly-wheel rim it is sufficiently accurate to take it to a point half way between the outer and inner edges of the rim.

The object of the fly-wheel is to store up energy when the machine to which it is attached accelerates, or speeds up, and to give out energy when the motion is retarded. This acceleration or retardation may be due either to a fluctuation of the load or to a change in the applied energy.

Example 1.—An engine fly-wheel weighs 15 000 pounds and its radius of gyration is 8 feet. While running at 100 revolutions per minute an extra load is thrown on, causing the speed to drop to 95 revolutions. How much energy is given out by the wheel?

Calculate energy at 100 revolutions and then at 95 revolutions, and subtract the latter.

Velocity in feet per minute = circumference of circle of radius 8 feet × number of revolutions. But as energy is computed by using feet per *second* for the velocity, we must divide this result by 60. Hence,

$$(a)\ \text{Velocity} = \frac{2 \times 8 \times 3.1416 \times 100}{60} = 83.78 \text{ feet per second.}$$

$$\text{Kinetic energy} = \frac{W\,v^2}{64.32} = \frac{15\,000 \times (83.78)^2}{64.32} = 1\,636\,909 \text{ foot-pounds.}$$

$$(b)\ \text{Velocity} = \frac{2 \times 8 \times 3.1416 \times 95}{60} = 79.59 \text{ feet per second.}$$

$$\text{Kinetic energy} = \frac{15\,000 \times (79.59)^2}{64.32} = 1\,477\,300 \text{ foot-pounds.}$$

Difference = 159 600 foot-pounds, answer.

A simpler way to have solved the example would have been to have squared the velocities, found the difference of the results, and then multiplied this difference by $\frac{15\,000}{64.32}$.

FORCE OF A BLOW.

It will be remembered that the principle of work, as applied to machines, teaches that, neglecting frictional or other losses, the work put into a machine equals the work done by the machine. This is merely a special case of the principle of the conservation of energy, and it can be used to find the force of the blow delivered by a hammer or a falling body. The work put in by the energy of a hammer at the instant of striking equals the work done in compressing or penetrating the material operated upon, and is equal to the resistance offered by the material, multiplied by the amount of this penetration.

EXERCISE 8.

1. Which has the greater capacity for doing work, a body weighing 64.32 pounds and moving with a velocity of 64.32 feet per second, or a body of the same weight suspended at a point 64.32 feet above the earth's surface?

2. From what height must a body weighing 48 pounds fall to acquire 976 foot-pounds of energy upon reaching the ground? *Ans.* 20 feet 4 inches.

3. A hammer-head weighs one ton and reaches the anvil with a velocity of 20 feet per second. (*a*) What amount of energy is stored up at the instant of the blow? (*b*) To what height would this energy raise a weight of 50 000 pounds? *Ans.* (*a*) 3 109.5, (*b*) ¾ of an inch.

4. The mean diameter of a fly-wheel is 20 feet and its weight 15 tons. How many foot-pounds of energy will the wheel accumulate if its speed changes from 60 to 61 revolutions per minute? *Ans.* 61 894 foot-pounds..

ANSWERS TO EXERCISE 7.

1. 7.9 seconds.

2. (*a*) To aid in the solution of this, formula 13 should have been transposed and written so as to give a value for h in terms of v. Thus,

$$h = \frac{v^2}{2\,g}. \quad \text{Solving, } h = \frac{2\,500}{64.32} = 38.87 \text{ feet.}$$

(*b*) Time of rising = time of falling =

$$\frac{v}{g} = \frac{50}{32.16} = 1.55;\ 1.55 \times 2 = 3.10 \text{ seconds.}$$

3. (*a*) 2 315.52 feet.

(*b*) Velocity at end of 9½ seconds = 305.52 feet per second; at end of 12 seconds it equals 385.92 feet per second. Mean velocity per second =

$$\frac{305.52 + 385.92}{2} = 345.72$$

feet per second. This times 2½ = 864.3 feet, the space required.

4. 46.64 seconds.

5. (*a*) .96 second.

(*b*) In the ratio to .96 second that 5 : 6.

It is clear that the resistance offered to the blow at any instant is equal to the force of the blow at that instant, and hence the work done equals the force of the blow multiplied by the amount of the penetration. It appears from this, moreover, that the force of a blow varies with the degree of penetration. Thus, suppose the energy of the first blow of a pile driver to be 10 000 foot-pounds, and that the pile sinks into the ground a distance of two feet. Before the ram can be brought to rest it must do 10 000 foot-pounds of work, and hence the average force acting must be 5 000 pounds; for 5 000 (the force acting) times 2 (the distance through which it acts) equals 10 000 (the available foot-pounds of energy.) At the second stroke, suppose the ram to deliver 10 000 foot-pounds of energy and the pile to sink one foot. Again the work done must equal the force times the distance, or in this case

10 000 × 1; that is, the force of the blow is twice as great as before.

Example 2.—If a hammer weighing 2 pounds strikes a nail with a velocity of 20 feet per second and drives it in one-half an inch, what is the force of the blow?

Kinetic energy of the hammer =

$$\frac{W v^2}{64.32} = \frac{2 \times 400}{64.32} = 12.44 \text{ foot-pounds.}$$

Since the energy is reckoned in foot-pounds instead of inch-pounds, the distance that the nail is driven should be taken in feet instead of inches. One-half inch $= \frac{1}{24}$ foot. Force of the blow $= 12.44 \div \frac{1}{24} = 298.56$ pounds, since $298.56 \times \frac{1}{24} = 12.44 =$ energy, or work put in = work done on the nail.

Example 3.—A drop-hammer weighing 50 pounds falls 6 feet and compresses a piece of steel $\frac{1}{100}$ of an inch. What is the force of the blow?

In the last example the velocity of the hammer was given so that the kinetic energy could be obtained. In this the height from which the hammer falls is stated and we must get the value of its kinetic energy from its original potential energy. This equals $50 \times 6 = 300$ foot pounds. $\frac{1}{100}$ of an inch $= \frac{1}{1200}$ of a foot. Force of blow $= 300 \div \frac{1}{1200} = 360\,000$ pounds.

Calculations like the above do not take into account the energy spent in heat, impact or other useless ways, but they serve to illustrate one of the important principles of mechanics. The formulas for the force of a blow are as follows:

Let D = amount of penetration.

" F = force of the blow.

Then for kinetic energy,

$$F \times D = \frac{W v^2}{64.32} \text{ or } F = \frac{W v^2}{64.32\,D} \quad (18)$$

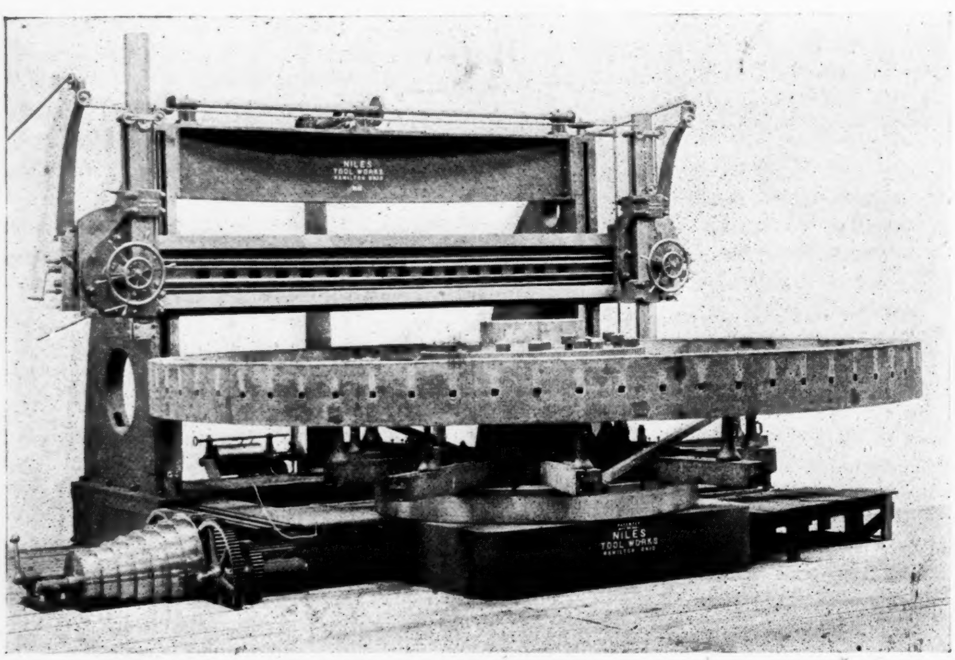
For potential energy,

$$F \times D = W h, \text{ or } F = \frac{W h}{D} \quad (19)$$

* * *

A HEAVY BORING MILL.

The accompanying photograph is almost a story without words, showing a 16–24 foot extension boring and turning mill of the Niles Tool Works, Hamilton, O., in operation on a 130 000 pound fly-wheel, 23 feet 6 inches in diameter, the housing being moved back on the bed as shown, illustrating the extension feature admirably. It also shows the method employed to hold this large wheel on the comparatively small table, the radial arms, the jacks and the inclined struts or braces to take the thrust of the tool.



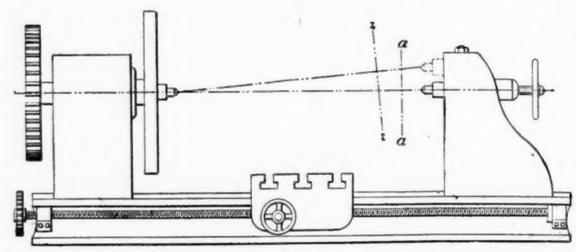
A HEAVY BORING MILL.

The rim of this wheel is 18×18 inches, and it was turned on the face and both sides in forty-eight hours, which speaks well for the stiffness of the tool as well as the efficiency of the operator.

DEFECTS IN BORING MILLS.

Some time ago Mr. H. S. Brown, then of the Delamater Works, called my attention to the fact that while in the last twenty years there had been a great many improvements in machinists' tools, one of the most important in the engine shop—the boring mill—has had but comparatively little real improvement—at any rate in the general engine shop, where they have a great variety of sizes in bore and strokes of cylinders.

The most common style is that shown in the figure (which I have enlarged from Mr. Brown's rough sketch), where there is a plain box bed with two heads supporting spindles in which are the centers on which the boring-bar runs. These spindles are raised and lowered by means of a small shaft and bevel gears



connecting to vertical screws with the heads, on the lower end of which, also, there are bevel gears. Between these heads there is a large platform carriage on which the cylinder is placed for boring. In the operation of boring, the cylinder is carried back and forth by the carriage on which it rests; and it is also moved in a line parallel with the V's of the bed.

The boring-bar does not move horizontally, but simply rotates on the centers. Now (pointed out Mr. Brown) in the boring of the cylinder it is no detriment to the boring to have one of the centers say a half inch higher than the other, for the bore will be parallel with the V's on which it is carried as above mentioned; but when we come to face the ends of the cylinder, then we meet the difficulty. If the centers are both the same height, then the cylinder will be faced at right angles with the bore; but if one center is higher than the other, we have the facing as shown at *x x*. If a cylinder is bored and faced as shown at *a a* it will, when bolted on its frame, show a line through it, parallel with the guides in which the crosshead works, a very desirable point to gain. On the other hand, if the cylinder be faced as shown at *x x*, when it is bolted on the frame, the man who tries the line will very suddenly find both hands in his hair, hunting for an explanation.

The above is no imaginary scene. Mr. Brown said most feelingly, "I have 'been there' and have filed and chipped on the guides on end of cylinders for days, depending of course on the size of the engine as to how long it took to fit the cylinder to the frame parallel with the guide.

"Now to avoid this difficulty it is essential to have both centers exactly the same height from the bed, and this must be looked after every time that the centers are raised or lowered. The least wear of one screw over the other will cause an error in facing. A boring-bar well proportioned with a traveling head will do better work and will face square with the bore every time, though one end be three inches higher than the other."

This bar can be used in any ordinary engine-lathe, and if there are no cylinders to bore you can put in a shaft or crank and keep the tool in use, unlike a large boring-mill that must lie idle when there are no cylinders to bore, thus tying up a large sum of money. G.

* * *

Owing to illness, Mr. Geo. Richmond was unable to supply the second paper on "Gas Engines," for this issue.

MORE ABOUT ADVERTISING.

J. P. Williams.

I read with interest the article on advertising by Mr. Ridgeway in your April issue. It is a matter which interests me particularly, as it is a part of my duty to make up the advertisements for the firm with which I am connected.* Many of the suggestions which Mr. Ridgeway made are good, and all advertisers will do well to read the article. It is a question, however, in the minds of most manufacturers of machine tools, how far a diversion from established methods would be beneficial. While the stereotyped method of presenting a line of machinery is often stiff and dull, yet the endeavor to be original and striking, and to put freshness into the advertisement. is quite liable to be overdone and to run into grotesqueness rather than individuality. There is a strong doubt in the writer's mind whether the readers of an advertisement of a piece of machinery would be more impressed by a rough and ready description or by a plain statement of facts in as few words as possible.

The purchase of a machine tool is to the majority of buyers a more or less serious matter, and one which is duly and carefully considered before the purchase is made, during which period the intending purchaser carefully scans the advertising columns of the papers, and consults the catalogues of various manufacturers. Now while the advertisement which hits him hard, as though with a club, may make an impression on his mind, is it not true that he will have more confidence in a machine so advertised that its merits are simply and plainly stated, than in one which is heralded forth in leaded catch words or slang phraseology. The same may be applied to catalogues also. The writer has seen and read with interest many catalogues which were original and striking, both in their design and execution, in the drawings and in the wordings, but when once read they are laid aside more as a curiosity than for reference, in regard to sober facts. I have received within a few days two catalogues of this class, one of a bicycle and the other of a machine tool; neither of which said a single word regarding the merits or construction of the article advertised, leaving me as much in the dark as before on points concerning which I wanted information.

The question of machinery advertising is one which the writer has never seen discussed anywhere. He reads *Printers' Ink* and gets from it many hints, but that estimable publication does not touch on matters dear to the heart of the machinery advertiser. The great lengths to which the ingenuity of the "addsmith" may carry him are strikingly set forth in the bicycle advertisements seen everywhere. The most of them teem with pretty pictures, the latest slang, pieces of poetry or quotations from other people, but very few of them give convincing facts to their readers. The X ray is an accepted scientific fact, but does its appearance whether in an advertisement of a planer or hosiery add anything to the reader's stock of information, or give him points on the advisibility of his buying the thing advertised? The men who are paid the largest salaries as advertising writers, do not use any of these extraneous ideas.

Many of the readers of Mr. Ridgeway's article would have been grateful if he had touched upon a few other matters connected with the detail of advertising. For instance, what is the value as an advertising medium of a paper having a free circulation among the trade, compared to one having only a paid circulation? Is a large space every other week as valuable as half the space every week? Will the makers of machines which are mainly used by bicycle manufacturers derive as good results from advertising in bicycle papers as from standard machinery papers? Is it advisable to use a cut for every advertisement? Should the man who makes a large line of tools advertise only one thing at a time, or should every advertisement contain a list of all his products? And now with the kind permission of the editor, I ask what is the advantage of advertising in trade papers and mechanical journals as compared with a thorough system of circularizing by means of a mailing list? I am sure that a discussion of these points and many others would be of great benefit to the readers of your paper.

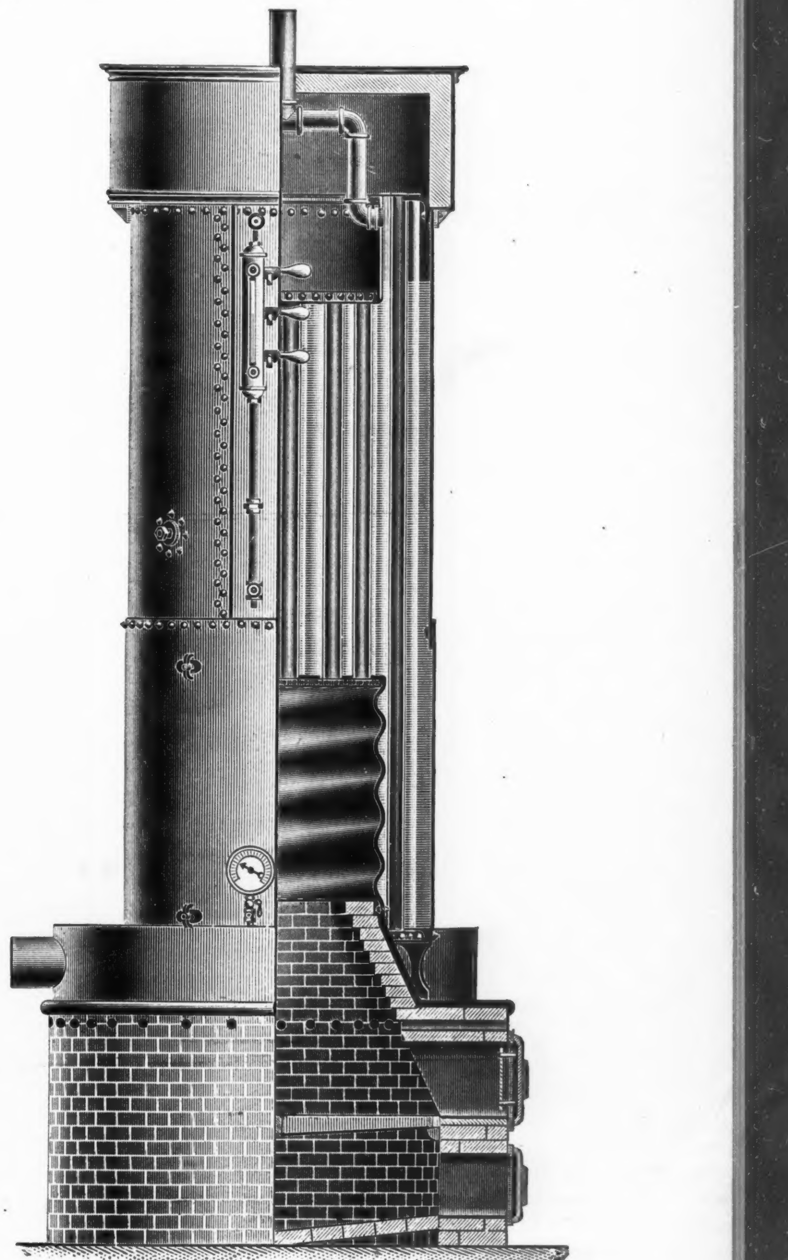
* The Diamond Machine Co., Providence, R. I.

* * *

THE WEBBER VERTICAL BOILER.

This boiler, although somewhat similar to the Reynolds vertical boiler, which has given the highest efficiencies of any type of boiler under test and in actual every-day practice, yet possesses many points of advantage. Being simply mounted upon a brick furnace, it has none of the expensive features of construction, such as mud rings, stay bolts, etc., incident to that form where the lower part of the boiler forms the furnace, nor any place where the sediment can settle and bake hard.

The furnace, being of brick, allows of the highest temperatures being realized by complete combustion, and the combustion in the conical furnace, with air-inlet pipes above flame-bed, make of the furnace a very large Bunsen burner, which is everywhere recognized as the hottest. The height of the flue sheet of boiler



above grate and the consequent combustion chamber allow space to complete practically perfect combustion. The hot gases then passing through the large diameter, short length flues give out the heat very rapidly, enter the fire-brick hood, which acts as a superheater, and, passing down through the smaller diameter long tubes on the outer circumference of boiler, act as an econo

mizer to utilize all the available heat from the gases not actually needed to produce a draught.

These boilers have eight hand-hole plates, four at the bottom and four at the top of combustion chamber which is of the corrugated type, to allow of expansion and contraction as well as to produce necessary strength without the use of stay bolts, and the design admits of machine riveting entirely.

Its complete accessibility for repairs (the hood can be lifted off of boiler, or the boiler off of furnace, and laid on its side) the advantages of a brick furnace of a circular form being the strongest construction, with no corners to crack, are in its favor. The cleaning both of boiler and flue is at the bottom in easy reach of fireman.

Further particulars can be obtained from Wm. O. Webber, 78 Mason Building, Boston, Mass.

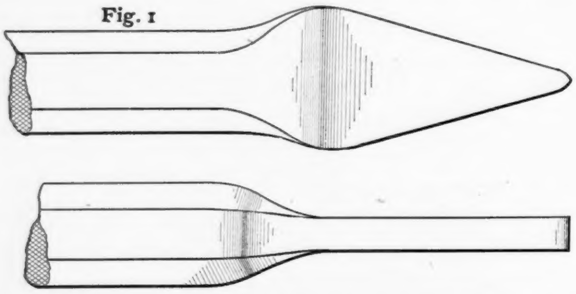
* * *

CUTTING HOLES IN BOILERS.

"QUIRK."

This must not be understood as attempting to instruct boiler makers in anything relating to their business, as this would undoubtedly seem presumptuous in a machinist. But as boilers are frequently brought into the erecting shop to be worked on, it becomes necessary for the machinist to acquire some knowledge

Fig. 1



of the arts practiced by sheet metal workers. That of cutting holes in the most expeditious way may be regarded as one of these. The ratchet drill and "old man" is the machinist substitute for the drill press, but when told that a hammer and chisel serves a better purpose in sheet metal, a round nose, or gouge chisel, usually suggests itself, and after a persistent test of this method he is still more than half convinced that ratcheting is the best, and about as expeditious.

The foreman, however, insists on the chipping process, for he has seen this successfully practiced, but like many of his class, is not disposed to take hold and give his workmen a practical lesson. They are told to use cape chisels in place of gouges, for starting, and when a small hole is made to then use the round-nosed chisels. A lot of cape chisels are dressed after the usual fashion, and five or six of these are broken before the boiler-sheet is penetrated; so the machinist goes back to the more blunt gouge, being satisfied that the little chisel will not work.

In the above proceeding we may discover the reason why so many attempts at shop reforms utterly fail. As a guide to such efforts, the foreman or manager often has nothing but mere hearsay, or perhaps he may have seen certain things done at other places which were worthy of adoption, and seemed perfectly easy to do, but, as imitators usually learn, he soon finds that more or less of skill and practice is necessary to the accomplishment of these undertakings. Then again, as we all know who have had charge of workmen, it is hard to get them out of old ruts, or ways to which they have become accustomed, it being usually harder to unlearn than to learn.

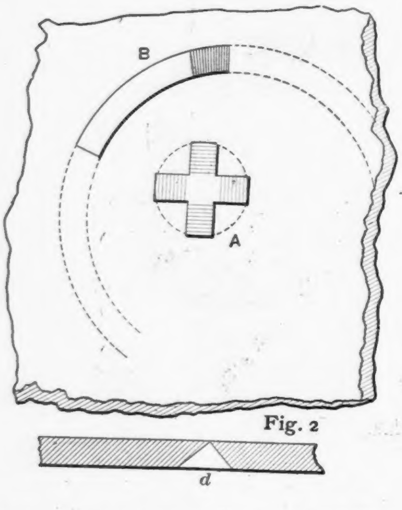


Fig. 2

In the matter of cutting holes in boiler plate, the failure referred to undoubtedly lay in not securing the proper form of chisel. Fig. 1 shows two views of such a tool having the proper form, the edge should be from $\frac{3}{16}$ to $\frac{1}{4}$ of an inch wide, and taper enough to make the cross-section square at a point about $\frac{1}{2}$ inch from the end. This form will stand vigorous hammering, and a few strokes will remove a chip as shown in Fig. 2. The chisel may then be driven through the sheet, and up to a point where the hole will be made square. If a larger hole is required, the first cut may be extended and a cross cut taken, as seen at A. Here the round-nosed chisel comes into play before using the drift-pin. This process will be found to be much more expeditious than when all the chipping is done with a gouge chisel.

In practice I have found that an allowance of $\frac{1}{8}$ to $\frac{3}{16}$, or even $\frac{1}{4}$ of an inch, may be allowed for drifting, especially when the hole is to be tapped for a stud, or cap screw. By this the metal is upset so as to greatly increase the strength of the thread. All this of course applies to ordinary boiler shells ranging up to say $\frac{1}{2}$ inch in thickness, or perhaps $\frac{3}{4}$; above that, as a matter of course, drilling must be resorted to. But in the thinner plates holes of any size say above $1\frac{1}{4}$ may be cut best with the cape chisel, and much time and labor is often saved by cutting around the periphery with the narrow chisel, as shown at B.

I am aware that boiler makers often prefer to use a diamond point for doing this kind of work, but this, when done quickly, requires two hands, one to strike, and is sometimes objectionable on account of the very rough and beveled edge which it leaves. In order to make the narrow chisel work successfully, it should be made of a good quality of steel, and tempered somewhat softer than usual, that is, approaching, if not quite down to, a blue. The use of a little oil on the point of the chisel will increase its efficiency.

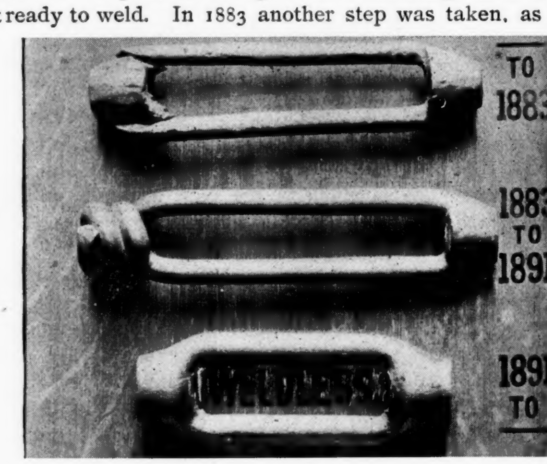
* * *

MR. F. M. RITES, well known by his papers before the A. S. M. E., has severed his connection with the Westinghouse Machine Company, Pittsburgh, Pa., and is now located at Ithaca, N. Y., where he will give attention to the introduction of his engineering specialties and inventions.

* * *

THE EVOLUTION OF TURNBUCKLES.

The advance made in the manufacture of turnbuckles is probably not appreciated by many, and the accompanying illustration tells the story in a plain and concise manner. The practice prior to 1883 was to take two round bars and weld them to the ends as shown in the top view, the right-hand end being finished, the left just ready to weld. In 1883 another step was taken, as shown,



the ends of the rods being twisted together to form the ends, the whole then being finished as seen at the right. The latest development is shown at the bottom, being the drop-forged turnbuckle as has been made since 1891. These show the advances made by Merrill Bros., of Brooklyn. N. Y., in this line.

This firm has recently brought out a new drop hammer, which has an improved lifting head; the principal feature being the substitution of a solid wrought steel eccentric shaft, placed at the back of the machine and connected with the side rods by a long forging. The eccentric shaft has fixed bearings at each end, the movable friction roll being advanced in a straight line, exactly opposite the fixed roll, so that the lifting board is always clamped squarely without regard to its thickness. The swinging friction roll generally used does not accomplish this result. These are not the only good features of the hammers, and those interested should obtain further details.

SETTING VALVES OF LOCOMOTIVES.

FRED E. ROGERS.

In most locomotive repair shops valve motion is something regarded with awe and to be spoken of with respect if not a sort of veneration, and the art of setting valves as something quite beyond the ordinary everyday machinist. The reason for this it is not difficult to find, as in most shops this work is done by one man, who, having charge of the work, trams and other tools, is held responsible for the accuracy of the work, and by various mysterious operations he conveys to the uninitiated the idea that this work is something quite above his plane.

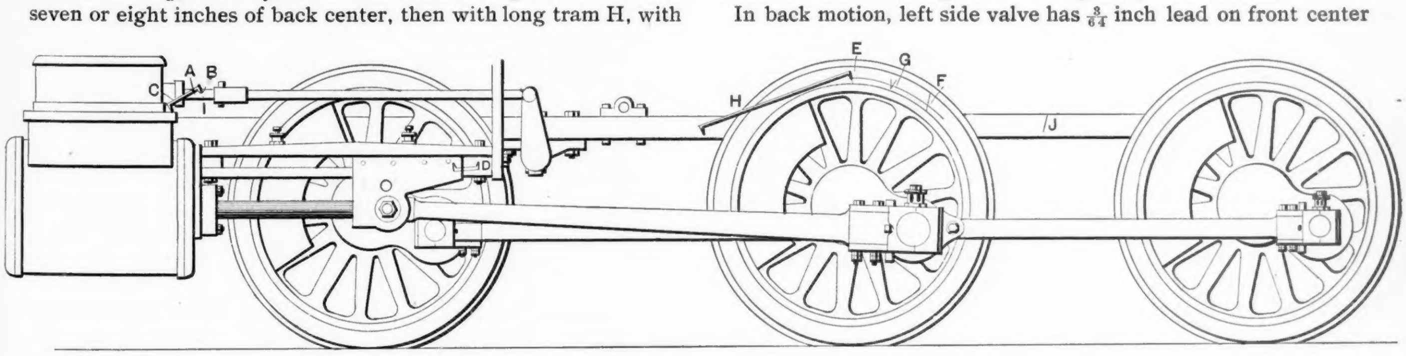
Railroad men too are, as a rule, in the dark as to what takes place in the steam chest, and how to remedy any minor defects, for in the days of slipped eccentrics the engineer who could adjust one so as to get home was regarded as superior to ordinary mortals. These doubts and ideas arise from misunderstanding a simple mechanism, which, although complex in its movements, effects a simple and easily understood operation.

The Stephenson link motion is almost universally used on locomotives and on marine engines, and although it may be defective, as is claimed by many eminent authorities, it stands to-day the simplest reversing and valve regulating mechanism in existence. So we will suppose the locomotive on which we are to work is a mogul, with link motion, balanced valves, with $\frac{3}{4}$ inch lap $\frac{1}{16}$ inch lead, in full motion, both forward and back gear, that rockers are 11 inches long at top arm and 10 inches long at bottom arm. Eccentrics have $5\frac{1}{4}$ inch throw and all parts are of standard length, as hangers, etc., also that lost motion of parts has been taken up and engine is ready for road.

Before steam-chest covers are put on, the position of valves at the moment steam is admitted to piston is marked on valve stems, with short tram C having one point in prick, mark on some immovable part as the cylinder top. These are called the "openings," and are of course twice as far apart as the lap of valve, and in this case $1\frac{1}{2}$ inch. A and B show on valve stem under tram.

These are taken for convenience in first setting and for readjusting in future, as has often to be done because of wear and accidents.

Commencing, if handy, on left side, move engine until within seven or eight inches of back center, then with long tram H, with



one point in prick mark on frame, scribe short arc E on main driver, and at same time, with short tram D, from prick-mark on guides, mark on crosshead, then move engine ahead until crosshead passes dead point and mark again coincides with tram point. With long tram from same prick-mark as before, scribe arc F. With dividers find center between two lines, which will give the point G. Move engine back with reverse lever in back notch of quadrant until tram-point reaches G. Engine is then on back dead center. With tram used in taking opening and from same prick-point, scribe line on valve-stem. Measuring from this to opening line we find it to be $\frac{5}{64}$ inch *outside* of opening line, and will be so much lead. Have paper or board marked thus:

R.	L.
F. F. C., F. B. C.	F. F. C., F. B. C., $\frac{1}{8}$ blind.
B. F. C., B. B. C.	B. F. C., B. B. C., $\frac{5}{64}$ inch lead,

which means forward motion front center, forward motion back center, backward motion front center, etc., and R. and L. for right and left side of engine.

Under L. after B. B. C., mark $\frac{5}{64}$ inch lead, which means you have found $\frac{5}{64}$ inch lead at back end of stroke in back motion on left side. Put reverse lever in forward motion and move engine back a few inches to take lost motion and then ahead till tram-point again comes to G; with valve-stem tram again scribe line on stem. This is $\frac{1}{8}$ inch inside of opening line, or in other words valve has not yet opened. We mark this on board $\frac{1}{8}$ inch blind after F. B. C., which means in forward motion at left back center valve lacks $\frac{1}{8}$ inch of being open. Continuing these operations until all four centers are found and positions of valves ascertained, we have as follows:

R.	L.
F. F. C., line.	F. F. C., $\frac{1}{4}$ inch lead.
F. B. C., $\frac{1}{8}$ inch lead.	F. B. C., $\frac{1}{8}$ blind.
B. F. C., $\frac{3}{8}$ inch lead.	B. F. C., $\frac{3}{64}$ inch lead.
B. B. C., $\frac{1}{2}$ inch blind.	B. B. C., $\frac{5}{64}$ in lead.

On right side in forward motion on front center, valve is just opening, or line and at back center, there is $\frac{1}{8}$ inch lead, now to equalize the lead valve will be moved back $\frac{1}{16}$ inch. To do this the eccentric straps are generally provided with slotted holes where blade is connected, and so if valve is to be moved back $\frac{1}{16}$ inch, we will *lengthen* top eccentric blade this amount minus about $\frac{1}{64}$ inch.

Right side back motion has on front center $\frac{3}{8}$ inch lead and at back center $\frac{1}{2}$ inch blind. Subtracting blind from lead gives $\frac{1}{8}$ lead to be divided between two ports, or $\frac{1}{16}$ inch each; so will move valve ahead amount of blind, or $\frac{1}{2}$ inch plus $\frac{1}{16}$ inch lead, or $\frac{9}{16}$ inch in all. Following this movement through rocker to lower eccentric blade, we will *shorten* blade this amount if rockers are the same length, but on this particular engine upper arm is 11 inches long and lower one 10 inches, so movement will be reduced to $\frac{10}{11}$ of $\frac{9}{16}$, or about $\frac{1}{2}$ inch, to which add $\frac{1}{64}$ inch. This $\frac{1}{64}$ inch is added to movement of blades when shortened and subtracted when they are lengthened, as it gives better results in practice. The explanation is that when parts are newly fitted, wear is comparatively rapid, and as the wheels wear ahead in the boxes, by the time engine is in working order the excess of movement will be taken up.

On left side in forward motion valve has $\frac{1}{4}$ inch lead on forward center and is $\frac{1}{8}$ inch blind on back center; subtracting blind from lead gives a net lead of $\frac{1}{8}$ inch. One-half of this or $\frac{1}{16}$ inch plus $\frac{1}{8}$ inch blind gives $\frac{3}{16}$ inch movement $\times \frac{10}{11}$ equals $\frac{11}{64}$ inch plus $\frac{1}{64}$ inch or $\frac{3}{16}$ inch again, which top eccentric blade will be shortened, or again add together $\frac{1}{4}$ inch lead and $\frac{1}{8}$ inch blind, which gives $\frac{3}{8}$ inch, dividing by 2 gives $\frac{3}{16}$ inch movement, which is the same thing, but not so quickly understood.

In back motion, left side valve has $\frac{3}{64}$ inch lead on front center and $\frac{5}{64}$ inch on back center. The lower eccentric blade is correctly set with $\frac{1}{64}$ inch allowance for wear. In small movements the difference in length of rocker arms can be disregarded.

Now the valves are set, which means simply that the lengths of eccentric blades are such that in both forward and backward motion the valves are in position to take steam equally at each end of stroke to cut off at practically the same distance from each end of stroke and exhaust at regular intervals so to sound "square," as it is termed.

After the first adjustment it is well to run over points again

and see if the movements show correctly and if there is reason to believe the motion is distorted or improperly designed, so that the cut-off and exhaust will not be "square" in all notches of the quadrant, hook reverse lever in notch where cut-off will take place at about 10 inches, and go over work again.

If then, for example, on right side it is found that on front center lead is $\frac{5}{16}$ inch and at back center $\frac{7}{32}$ inch shorten both blades $\frac{1}{16}$ inch. Sometimes it will be found that the engine still goes lame, and it will be necessary to adjust valve from exhaust point instead of opening.

In taking openings the middle point between A and B is generally found, and when tram-point coincides with this, valve is on lap, and if it is line and line in the exhaust cavity either port will open to exhaust the moment valve is moved right or left. We will consider this valve to be line and line and will move engine ahead with reverse lever hooked in 10 inch notch until the center mark I between openings comes to tram-point. With long tram H from center G on driver mark on frame at J. Move engine ahead one half turn until with tram in center opposite to G the other point again coincides with J. With valve-stem tram again scribe on valve stem. Suppose this line is $\frac{1}{8}$ inch from center mark I and to the right of it. Then both eccentric rods will be lengthened $\frac{1}{16}$ inch.

When valves need readjusting on account of wear it is not necessary to go through the original operation in full. The dead centers must be found again and openings proved correct, but in taking centers move engine up to center with lever in forward motion, take up slack of parts by pulling top arm of rocker *back*, as this is the direction in which nine-tenths of the wear takes place, on account of displacement of valve stem; then take opening with valve tram, now reverse engine without moving, take up slack as before and again take opening. This saves one-half the pinching of engine and gives equally as good results.

Care and experience are required to give the best work, but the apprentice can easily understand the principles and if need be put them in practice.

* * *

MACHINE SHOP DRAWINGS should be stiff flat, and never rolled. The best way to prevent this is to paste them upon heavy tar-board or upon thin pine or poplar boards, and varnish them with white shellac varnish. It is well to varnish before the figuring and lettering are put on, so that if it be necessary to change the lettering the last coats of varnish can be sand-papered off and the lettering changed, without the lines of the drawing having to be touched.

DEMOLISHING A CHIMNEY—PILE DRIVING.

S. ASHTON HAND.

On the site purchased by the Government for the new Philadelphia Mint stood originally the Norris Locomotive Works, which have long since passed into history. Part of these works were incorporated into the plant of the Bush Hill Iron Works, which were in operation at the time the Government bought the property. At the time of my visit all the buildings had been torn down, and the only thing left was the stack, as shown in the first photograph. This stack was star-shaped in section and 110 feet high. The contractor considered the old method of scaffolding around it and tearing it down piecemeal too expensive both in time and money, and as there was plenty of room around it he concluded to try the effect of dynamite on it. The base was tunneled through in both directions, leaving the stack to rest on four piers. This does not show in the photograph, for the reason that the picture was taken from a point where the view of the base was obstructed by the ground floor of the machine shop, which was on higher ground than some other parts of the works.

The two eastern piers were charged on the inside with a pound of dynamite. This was exploded, and, as was expected, reduced the amount of material in the piers so as to make the next charge sure of destroying them. The next charge of dynamite was about four pounds, and this, when exploded, completely demolished the two piers and allowed the stack to topple over to the eastward. It came down without fracturing until it struck the ground with a "dull and sickening thud," as the reporters would have said, when it simply went to pieces. Photograph No. 2 was taken when the stack began to fall, and No. 3 was taken about a second later. No. 4 was taken within 15 minutes after the fall, and shows how complete was the demolition.

At the lower right-hand side of the stack in No. 2 will be noticed a blurred and spotted appearance. This is simply an instantaneous record of the commencement of disintegration at the time of exploding the dynamite. Fig. 3 shows further progress of disintegration, in fact a large part of one of the panels is seen in the act of leaving the mass. Photographs Nos. 2 and 3 were taken in $\frac{1}{25}$ of a second at 5.15 on a dark, cloudy afternoon, which accounts for a lack of detail in the illustrations.

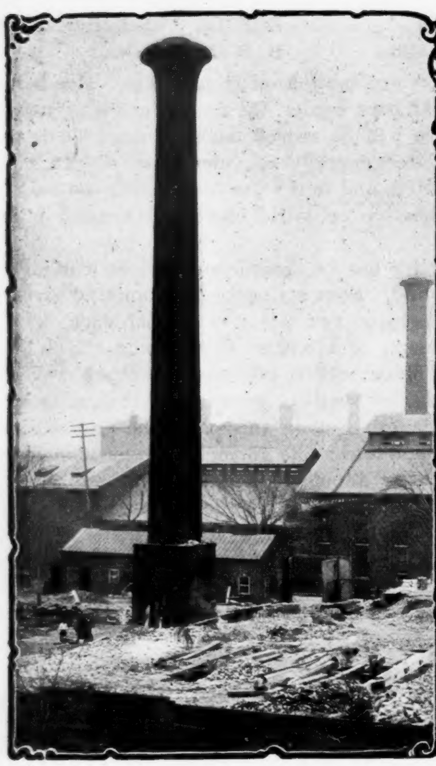


FIG. 1.—READY.

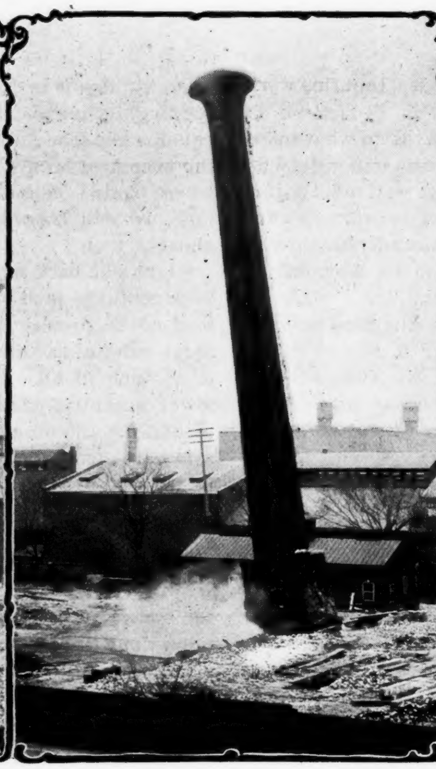


FIG. 2.—GOING!

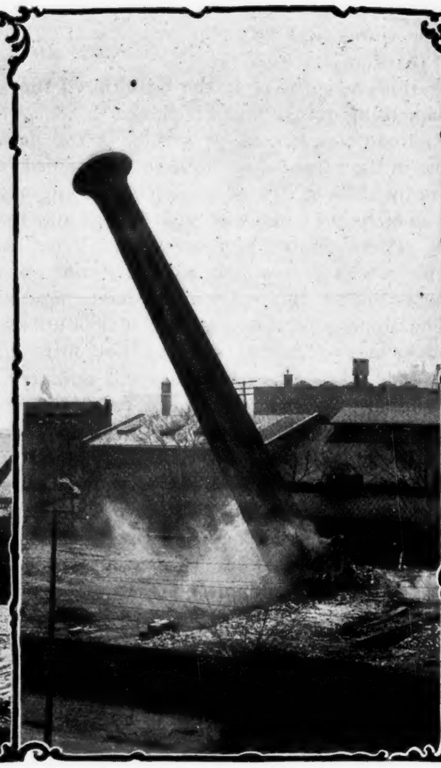


FIG. 3.—GOING!!

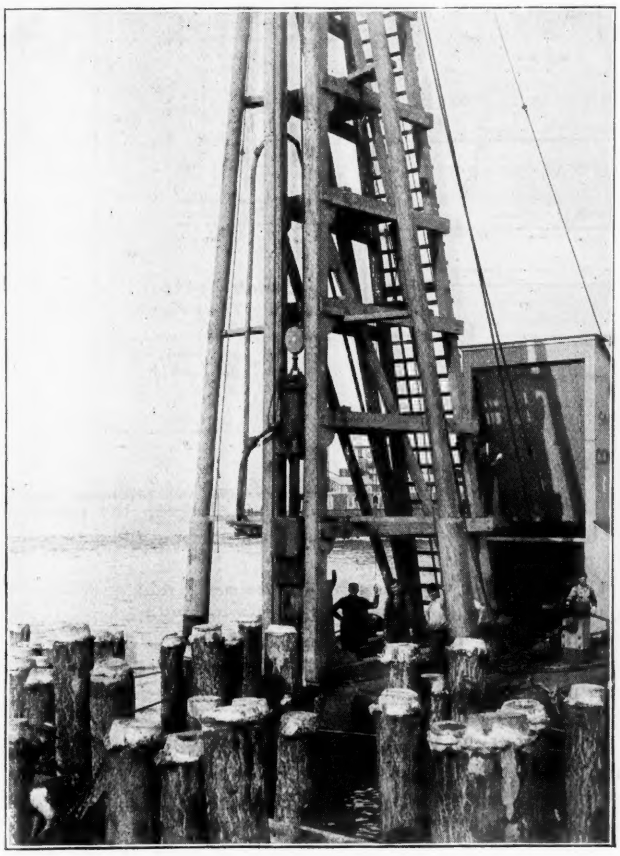
DEMOLISHING A CHIMNEY.

The steam pile driver shown in the accompanying illustration has some novel features. The old-fashioned drop pile driver depends for its efficiency solely on the impact of a falling weight, and the gunpowder pile driver depends on the force of an explosion, while the pile driver in the illustration depends for its

efficiency not only on the impact of the steam-driven ram, but also on the weight of the whole machine, plus the force necessary to raise the ram to the point from which it descends.

FIG. 4.—GONE!!!
DEMOLISHING A CHIMNEY.

As will be seen in the illustration, the cap which rests on top of the pile to be driven is connected to the steam cylinder by four vertical rods, which also act as guides to the ram. The whole machine slides vertically between ways or shears. In operation



DERRICK.

the machine is hoisted up so that a pile can be placed under it. When the pile is put in place and the machine lowered onto it, the driving commences, blows being struck at the rate of 62 per minute. As each blow tends to drive the pile downward, so also does force used to lift the ram again exert a downward force which prevents the pile from recoiling, making a decided gain. With the data below will also be found some interesting facts regarding piles both with and without protecting points.

The total weight of the machine is 9 200 pounds. Weight of ram, 4 200 pounds. Steam cylinder, 13½×36 inches. The piles are from 50 to 80 feet in length and from 18 to 30 inches diameter at the head and 8 to 14 inches diameter at the point. They are driven into the river bottom an average of about 20 feet, of which 8 feet is mud and 12 feet is hard-pan. They are driven until they will not go down more than ¼ inch with ten blows of the ram. About 200 blows are necessary to drive the pile home.

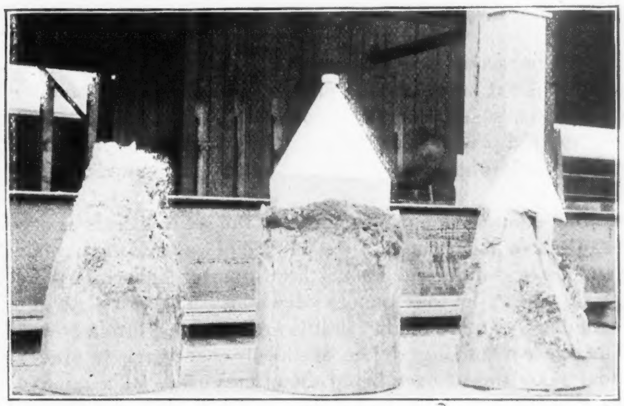
Piles with cast iron conical points, with cast iron pyramidal points and without any points, have been driven and then pulled up, to test their respective holding powers. Though in each instance these piles were practically driven home by 200 blows, they were each struck 100 extra blows, or 300 in all, to make sure that they were actually home. The pile with the conical point penetrated 8 feet of hard-pan, the pile with the pyramidal point penetrated 10 feet, and the bare pile penetrated 9 feet.

In pulling up the piles that were shod with points no difficulty was experienced, while in pulling up the bare pile the forward deck of the pile-driver float was pulled under water, at which time the 1½ inch hook at the lower block was broken. A new hook was put on and the pulling continued until the forward deck was again submerged. Matters were left to remain in this state for two hours without the pile showing any tendency to come up. Finally the pile was loosened by swaying it to and fro, and aided by heavy swells from a passing steamer it was pulled up.

In the accompanying small illustrations the lower ends of these piles are shown after they were cut off and stood up to be photographed.

* * *

Nearly every day a section of the country is given out to a bright young mechanic on our circulation work, which affords a chance to see life (the right kind), and to acquire practical information from observation, that cannot be equalled. There are lots of young mechanics who might take this in during the quiet summer months to their advantage. This work is better than a vacation, for it combines recreation with an opportunity to make something over your expenses, and to get hold of pointers that will be worth dollars to you in future. Read the advertisement following Machinery's Register.



BARE PILE. PILE WITH CONICAL POINT. PILE WITH PYRAMIDAL POINT.

PILE DRIVING.

PRACTICAL TALKS ON MECHANICAL DRAWING.—(8).

Louis Rouillion.

TRACINGS.

After a sheet has been finished in pencil, a tracing of it is made. Tracing cloth has a rough and a finished surface, either of which may be used. The finished surface has some advantages, as greater ease of making erasures, and less liability to blotting. It does not, however, take ink quite as readily as the rough side, but this defect may be remedied by rubbing over it powdered chalk or talc. The tracing cloth is tacked directly over the drawing, which is trued with the T-square. The ink lines should be moderately heavy, that the blue print may show firm, full lines. Ink in all circles and curves first, then beginning at the top of the sheet all horizontal lines. The dimensions and lettering are then added. The tracing may be used for making any number of duplicates in the form of blue prints.

BLUE PRINTS.

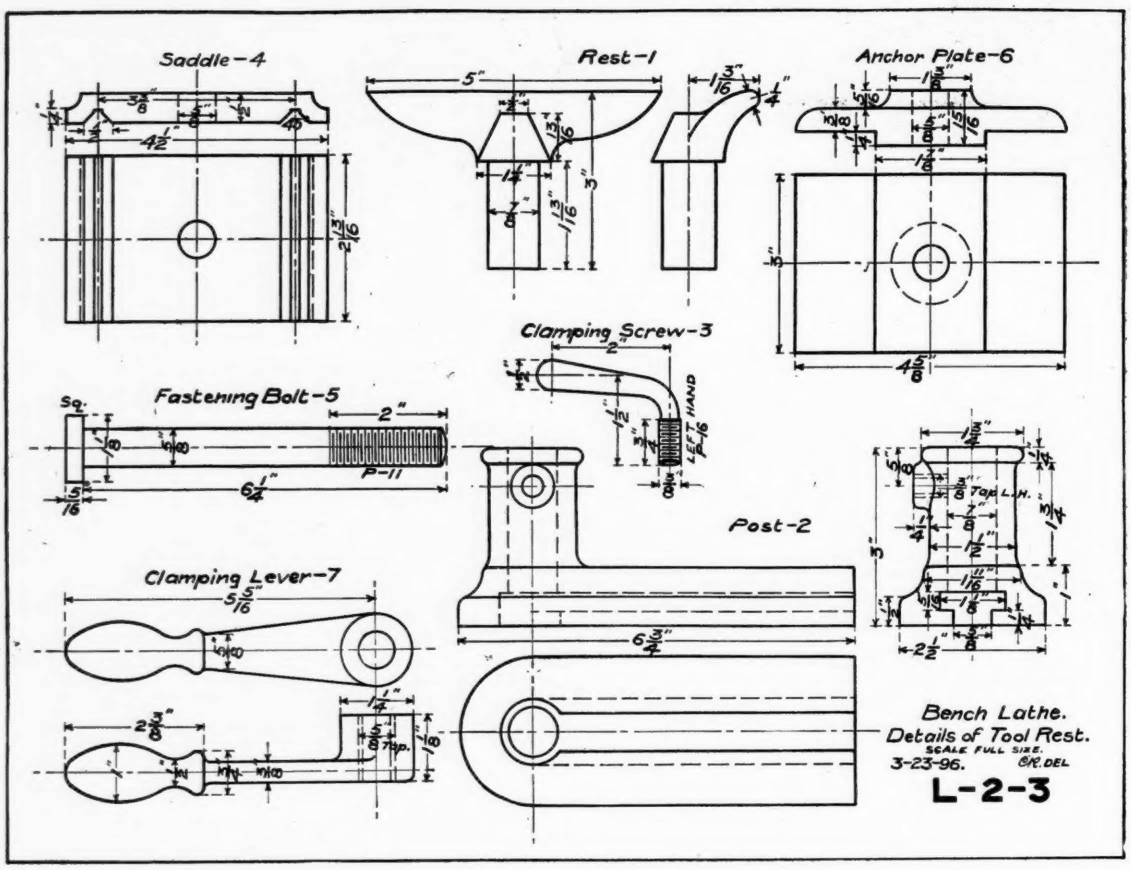
It is in the form of blue prints that the drawings generally reach the shops. The prints are made by exposing chemically prepared paper to the action of the sunlight and then washing in water. Prepared paper may be purchased from dealers in draftsmen's supplies, or it may be easily made as wanted. The chemicals required for sensitizing the paper are citrate of iron and ammonia, and red prussiate of potash. These may be purchased at any drug store and should not cost more than ten cents an ounce.

For making enough blue print paper for the set of drawings of the lathe, dissolve about one ounce of citrate of iron and ammonia in four ounces of water, and about three quarter ounces of red prussiate of potash in four ounces of water. The prussiate of potash will dissolve more readily if it is first pounded into a powder. The relative amounts of the chemicals used varies in practice; equal quantities of each being sometimes used. The quantities given above have been found by experience to yield a deep, blue color. After the chemicals are dissolved they are mixed together, and the mixture is spread upon the surface of a good, white paper. A soft paste-brush, about four inches wide, will be found serviceable for this purpose. Apply the solution evenly over the entire surface, and tack the sheet up in a dark place to dry. The paper is now sensitive to the action of light, from which it should be carefully guarded. The drying requires about an hour. The paper may be kept for some time without deterioration.

In offices where blue-printing is done, special printing frames are provided. These consist of a board upon which two or three thicknesses of flannel or other soft cloth is smoothly fastened, over which is hinged a sheet of heavy glass. The cloth furnishes a smooth, yielding surface upon which to place the paper and tracings and the heavy glass presses them evenly together while permitting the sunlight to act. The prepared paper is placed upon the cloth, sensitized face up, and the tracing is placed over it. They are held firmly together by the glass, and exposed to the direct action of the sun's rays. The time of exposure varies with the intensity of the sunlight, but from ten to three o'clock, at this time of year, an exposure of from five to eight minutes should be sufficient. The printing may be done without the direct action of the sun's rays, as upon a cloudy day, by extending the time of exposure to from one to two hours. When the paper has been exposed long enough, which is shown by the yellow color changing to a gray, it is placed in a bath of clean water, and allowed to soak for a few minutes. It is then rinsed off and hung up to dry.

In making very large blue prints the glass is dispensed with, and the paper and tracing are securely fastened to a board which is sprung to a slight curvature. For making home-made prints, any simple device may be used that will keep the paper and tracing firmly pressed together, and not obstruct the action of the sunlight.

If, after a blue print is made it is desired to add anything to it, as a measurement or a line, it may be done with caustic soda, which bleaches the blue, or Chinese white may be used. The finished parts of a machine may be shown upon the blue print by drawing lines with red ink adjacent to such parts.



PRACTICAL TALKS ON MECHANICAL DRAWING.—SHEET XXVII.

SHEETS XXVII.-XXIX.

In Sheet XXVII. but two views of the post are strictly necessary. The bottom view shows a little more clearly the shape of that part. The internal screw-threading on the post is shown by parallel hidden lines and by the note "3/8 in. tap." This method is also shown in the clamping lever. Where a definite pitch is not given for screw-threads, as in the case of the fastening bolt, it is understood to be standard. The bolt is five-eighths inches in diameter, therefore the pitch of the screw-threading is eleven, as will be seen by referring to the table given with Sheet XVI.

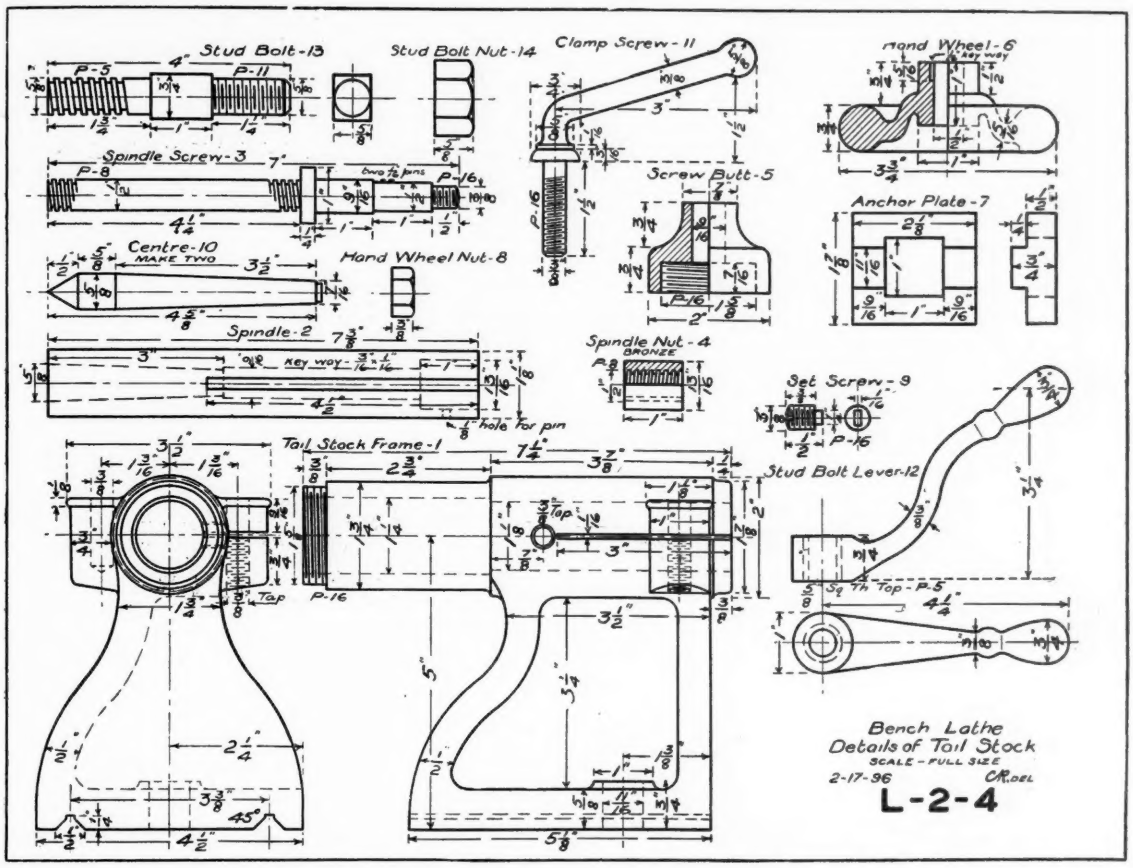
In Sheet XXVIII. but one view is shown of the stud-bolt nut and of the hand-wheel nut, in which the height of the nut is given. This corresponds with the diameter of the bolt when the

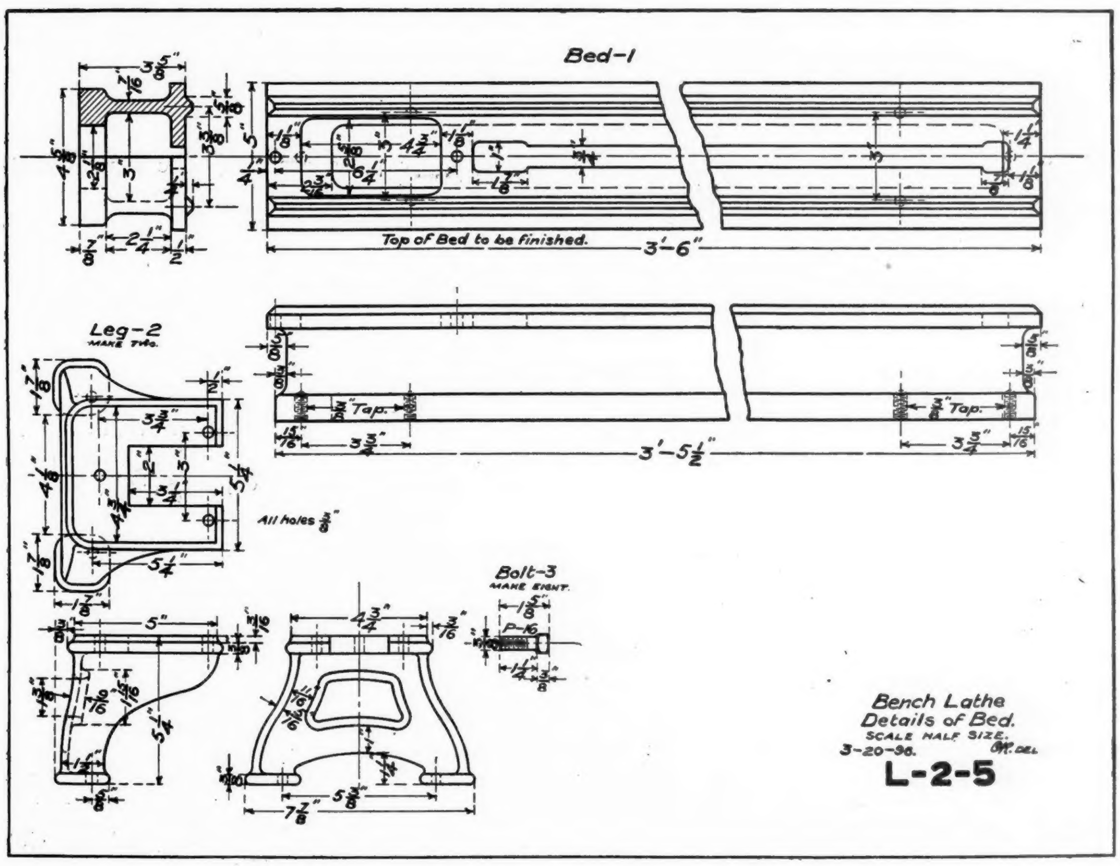
nut is standard, and so determines the tap. Another method of showing tapping is given in the tail-stock frame, where the threads are conventionally shown by hidden lines.

Sheet XXIX. is drawn to half-scale. Where a piece has the same structure throughout a considerable length, space may be saved by breaking out a portion, as shown in the drawing of the bed.

* * *

Strong glass plates are bored through by means of rotary brass tubes of the necessary diameter, which are filled with water during boring. To the water there is added finely powdered emery. Thinner glass may be perforated with holes in an easier manner, by pressing a disc of wet clay upon the glass, and making a hole through the clay of the size required, so that the glass is laid bare. Molten lead is then poured into the hole, and lead and glass drop down at once. This method is based upon the quick, local heating of the glass, whereby a circular crack is produced, the outline of which corresponds to the hole made in the clay. Care requires to be exercised, however, in using this method, as when molten lead is poured upon clay so that steam is generated from the moisture, the lead is very apt to fly.—*The Practical Engineer, London.*





PRACTICAL TALKS ON MECHANICAL DRAWING.—SHEETS XXVIII. AND XXIX.

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WE solicit communications from practical railroad men on subjects pertaining to their profession, for which the necessary illustrations will be made at our expense.

NEW YORK, JULY, 1896.

CONTENTS:

THE CONVENTIONS.

The conventions just held at Saratoga again demonstrate the value of interchanging experience and ideas, and show to what a large extent we are dependent on each other. The experience gained in every-day practice often seems very insignificant to us, and we imagine that everyone else must know all about it, until, at some convention or similar place, we find that others are still in the dark in this very particular, and that our little experience which we had been hiding from the light, is really valuable, and we give it gladly to aid others in their work. In the meantime we have picked up a great deal of information ourselves, and so the exchange goes on, each benefiting much more than he has benefited others, and each feeling well repaid for the time spent in attending the conventions, and the circle of acquaintances is constantly being widened, and is especially pleasant when one is traveling in different parts of the country.

There is one feature of the conventions, however, which mars the otherwise democratic nature of the gathering, and although rather a delicate matter to discuss, should, we think, be more freely spoken of. We refer to the matter of dress.

There are few railroad master mechanics who have more money than they can use in providing a comfortable home for their families, for they are, as a rule, poorly paid when their exacting and responsible work is considered. The conventions have become a trifle more fashionable than we think is healthy, either for the good of the associations or the pocket-books of the members. We know of several instances where members have refrained from taking their wives to the conventions because they could not stand the expense of the wardrobe necessary to compare in appearance with the wives of the other members, and of still others who did go, and whose families have been brought dangerously near the verge of bankruptcy as a consequence. This is not all confined to the ladies, but of course men, as a rule, are more careless about dress and are less affected by it. We believe the conventions can be made more enjoyable to all concerned if those who are fortunate enough to have an abundance of worldly goods will refrain from making the convention a place at which to display their wardrobe, and be content to wear simpler clothes and take fewer trunks, to the envy of the less fortunate. Say what we will about our democratic tendency, few feel entirely at ease when their clohtes are conspicuous by their plainness or by having been worn at all times, while their neighbors wear three or four different costumes each day.

* * *

BUILDING LOCOMOTIVES.

The building of locomotives is a rather peculiar business and one that has not yet reached the manufacturing stage, as even the largest of them can be said to be subject, to a large extent, to the whims of the buyers, and this of itself precludes the real manufacture of an article. Even the largest of the builders buy their boiler sheets all cut to size and shape (and they could probably be drilled for less money at the steel works than in the locomotive shop) and many other parts are bought complete, such as guages, injectors, oir pumps, etc., etc., although this does not prevent the remainder of the engine from being done on the proper scale. True some parts are made in quantities and used on all engines, but they are the exception.

The trouble is that every master mechanic has some pet scheme for saving money or becoming famous and he is bound to have this idea carried out, although it often adds to the cost of the engine and as often is rather a detriment than an improvement. This prevents the adherence to any standard of details as the change may be in almost any part of the engine from valve gear to the tender truck.

We know of one case in particular where the "frills" of the master mechanics specifications added $2000 to the cost of the engine, which was fortunately brought home to him by the management, who objected to the price, to be informed that had the regular engines been built the price would have been about 20 per cent less. This road at least, will order standard engines for a few years, until they forget the cost of having special work done. While it is desirable to build just what a customer demands, it is more economical for all concerned to be able to stick to a standard and not change patterns and designs for every whim of the purchaser. It may not be possible at present but it is certainly desirable.

* * *

THE *American Engineer*, etc., etc., has joined the ranks of the standard size journals and is much improved, not only in size but in quality. The combination, Messrs. Forney & Marshall, are putting more life into it than it has known since Mr. Sinclair left it.

SAND-SIFTING MACHINE.

JOHN L. KLINDWORTH.

Being at present interested in foundry improvements, especially as regards the economic handling and mixing of sand, I should be pleased to hear from other readers of your paper regarding the practice at their foundries in regard to the above named subject, particularly the core sand. Thinking it may be of interest to some of your readers I shall give a short description of a sand sifter shown in Figs. 1 and 2. Although not strictly the same as those built, yet the manner of suspension and working is the same. The machine consists of a frame, a swing frame B, sifter S and the driving gear. The lumber used is 1 inch thick excepting corner posts and pieces across the top of same. The sieve is of wires about ⅛ inch thick, very durable, and will outwear a great number of hand-riddles. Several sieves should be made, of course, for varying the fineness of the sand. The sieve has but three sides, the one end being closed by board A while sifting. This board is nailed to swing-frame B. It will be noticed that the sieve is carried by means of small trunions which rest on the swing-frame to enable one to tip it when it is desired to dump the coarse stuff. The dotted lines show the position of sieve while dumping the coarse material upon the sheet iron, whence it slides into a suitable receptacle. The swing-frame is suspended by three links 8 inches long by ⅝ inch diameter in such a way that while moving the swing-frame forward, one end of sieve and frame is lowered and the other end raised. If done rapidly enough the sand is thrown upward, and when striking the sieve again the lumps are more readily broken than by sifters of the usual construction, which have simply forward and backward motions, and the sand has a tendency to slide over the wire and close up the holes if it is rather damp. The connecting-rod may be made of oak or some other kind of hard wood. If the sifter is worked by hand power it should be geared about 3 to 1. Gears of about 6 pitch and 1½ to 1¾ inch face will do. If driven by belt or rope it may be driven direct at about 100 revolutions per minute of fly-wheel or driving shaft. It requires but little power, a ½ HP. motor giving ample power. This will be found more of a saving than some may imagine.

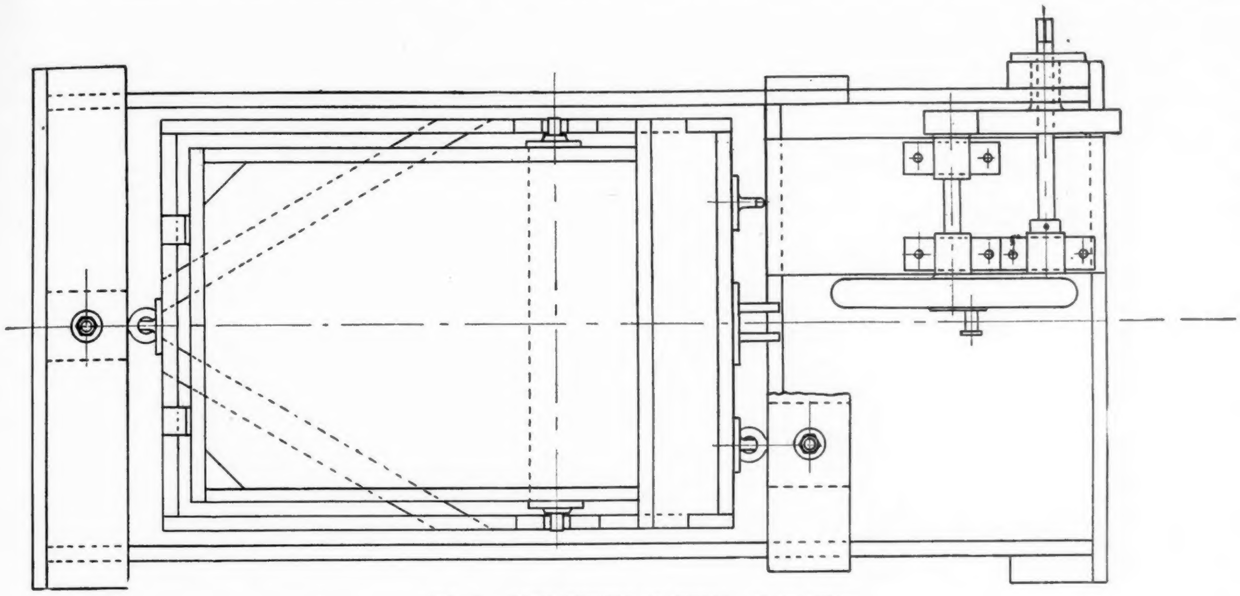


FIG. 1.—SAND-SIFTING MACHINE—PLAN VIEW.

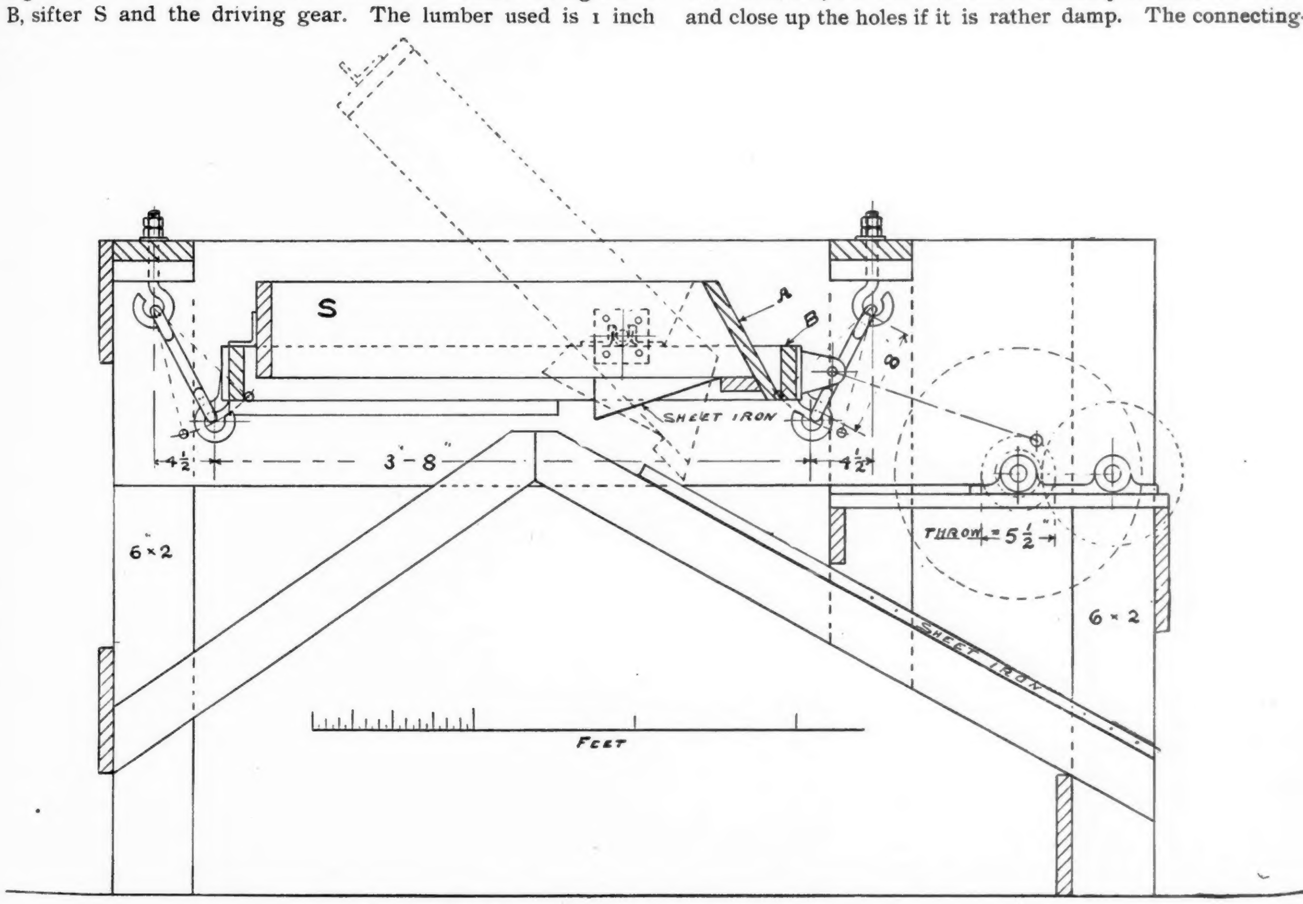


FIG. 2.—SAND-SIFTING MACHINE—SIDE ELEVATION.

EFFICIENCY OF BOILERS AND ENGINES,—3.

CALCULATING THE CORRECT COST OF RUNNING AN ENGINE.

THEO. F. SCHEFFLER, JR.

As an example the writer quotes a test made on the triple expansion engine in the laboratory of the Massachusetts Institute of Technology. In the above mentioned test the engine used 13.73 pounds of steam per horse power per hour, of which 10.86 pounds passed through the cylinders of the engine and 2.87 pounds were condensed in the several jackets of the engine. The B. T. U. supplied to the cylinders per horse power per minute were

$$10.86\ (0.988 \times 858.3 + 334.2 - 126.4) \div 60 = 191.1;$$

the boiler pressure being 157.7 pounds absolute, and the back pressure 4.5 pounds absolute, while the priming was 1.2 per cent.

The B. T. U. supplied by the jackets per horse power per minute may be calculated by the expression

$$2.87\ x\ r \div 60 = 40.6,$$

since the condensed water from jackets may be returned to boiler.

The notations of the above formulas are thus:

$$S\ (x\ r + q - P) \div 60 = \text{B. T. U. per minute.*}$$

Where S=pounds of steam per horse power per hour.
" p= " " " pressure absolute.
" q=heat of the liquid at boiler pressure.
" P= " " " " " back "
" x=quality of the steam.
" r=heat of vaporization at the boiler pressure.

One pound of moist steam contains x part dry steam and $1-x$ part of water; so that 2 per cent. priming will make x equal 0.98. The total consumption per horse power per minute would be thus:

$$191.1 + 40.6 = 231.7 \text{ B. T. U.}$$

The writer advocates this method of stating engine performance, not only because it is thoroughly theoretical and practical, but because it affords a simple and correct way of finding the efficiency of the engine, while an attempt to find the efficiency by other methods is liable to lead to confusion and error. If the boiler efficiency is calculated in B. T. U., why not figure the engine efficiency the same way, and by doing so bring the two together. Of course, we all know the usual way of determining the engine efficiency is by brake and indicated horse power; this of course gives the mechanical efficiency, and has been the ordinary way of finding the real available horse power of an engine. The efficiency is the ratio of the heat changed into work to the heat consumed. We all know that a horse power is 33 000 foot-pounds per minute, and Joule's equivalent would be 33 000÷776=42.52 B. T. U. per minute. Now by dividing the above constant 42.52 B. T. U. by the actual heat consumed per horse power per minute, will give the actual efficiency of the engine.

The efficiency for the test of the triple engine just mentioned is, 42.52÷231.7=.183, which is considered very good and shows a very high result considering the size and type of engine. At this point it will be well to show just what a perfect engine could do, that is where an engine has no waste or losses; of course this is quite impossible at the present day. Taking the same formula used a little further back we have

$$\frac{T - T^1}{T} = E$$

Consequently applying to the test under consideration would be

$$\frac{822.9 - 618.4}{822.9} = 0.2485$$

efficiency, assuming no losses or waste. Comparing the efficiency of a perfect engine with previous result found above .183 we have

$$\frac{0.183}{0.2485} = .736$$

per cent. of the total work that it was possible to do under the conditions. To calculate the theoretical cost per horse power

EFFICIENCY TABLE FOR BOILERS.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
				Per Cent. Efficiency for Probable Number of Heat Units Utilized by Boiler.		Equivalent Evaporation Efficiency Per Cent. over Theoretical Units Utilized to be Added or Subtracted to Column 6.					Equivalent Evaporation Efficiency Per Cent. over Number of Lbs. of Water Evaporated Per Lb. of Combustible, to be Added or Subtracted to Column 5.				
Heat Units in One Pound of Coal, B. T. U.	Water Evaporated Theoretical in Pounds.	Efficiency from 1 Pound of Combustion if all Per Cent. Heat Units were Utilized by Boiler.	Probable Number of Heat Units Utilized by Boiler.	Water Per Pound of Combustible.	Per Cent. of Theoretical Efficiency by Boiler.	Boiler Pressure, 55 Lbs. Feed Water, 104°.	Boiler Pressure, 75 Lbs. Feed Water, 122°.	Boiler Pressure, 100 Lbs. Feed Water, 140°.	Boiler Pressure, 131 Lbs. Feed Water, 158°.	Boiler Pressure, 131 Lbs. Feed Water, 212°.	Boiler Pressure, 55 Lbs. Feed Water, 104°.	Boiler Pressure, 75 Lbs. Feed Water, 122°.	Boiler Pressure, 100 Lbs. Feed Water, 140°.	Boiler Pressure, 131 Lbs. Feed Water, 158°.	Boiler Pressure, 131 Lbs. Feed Water, 212°.
14 500	15.	100	13 050	13.5	90	12.6	11.7	10.8	9.0	3.6	1.89	1.75	1.62	1.35	.54
14 400	14.9	99	12 960	13.4	89	12.4	11.5	10.6	8.9	3.5	1.87	1.74	1.60	1.34	.53
14 300	14.8	98	12 870	13.3	88	12.3	11.4	10.5	8.8	3.5	1.86	1.72	1.59	1.33	.53
14 200	14.7	98	12 780	13.2	88	12.3	11.4	10.5	8.8	3.5	1.84	1.71	1.58	1.32	.52
14 100	14.6	97	12 690	13.1	87	12.1	11.3	10.4	8.7	3.4	1.84	1.70	1.57	1.31	.52
14 000	14.5	96	12 600	13.0	86	12.0	11.1	10.3	8.6	3.4	1.82	1.69	1.56	1.30	.52
13 900	14.4	96	12 510	12.9	86	12.0	11.1	10.3	8.6	3.4	1.80	1.67	1.54	1.29	.51
13 800	14.3	95	12 420	12.8	85	11.9	11.0	10.2	8.5	3.4	1.79	1.66	1.53	1.28	.51
13 700	14.2	94	12 330	12.7	84	11.7	10.9	10.0	8.4	3.3	1.77	1.65	1.52	1.27	.50
13 600	14.1	94	12 240	12.6	84	11.7	10.9	10.0	8.4	3.3	1.76	1.64	1.51	1.26	.50
13 500	14.0	93	12 150	12.5	83	11.6	10.7	9.9	8.3	3.3	1.75	1.63	1.50	1.25	.50
13 400	13.8	92	12 060	12.5	83	11.6	10.7	9.9	8.3	3.3	1.75	1.62	1.50	1.25	.50
13 300	13.7	91	11 970	12.4	82	11.5	10.6	8.8	8.2	3.2	1.73	1.61	1.48	1.24	.49
13 200	13.6	90	11 880	12.3	82	11.5	10.6	9.8	8.2	3.2	1.72	1.59	1.47	1.23	.49
13 100	13.5	90	11 790	12.2	81	11.3	10.5	9.7	8.1	3.2	1.70	1.58	1.46	1.22	.49
13 000	13.4	89	11 700	12.1	80	11.2	10.4	9.6	8.0	3.2	1.69	1.57	1.45	1.21	.48
12 900	13.3	88	11 610	12.0	80	11.2	10.4	9.6	8.0	3.2	1.68	1.56	1.44	1.20	.48
12 800	13.2	88	11 520	11.9	79	11.0	10.2	9.4	7.9	3.1	1.66	1.55	1.43	1.19	.47
12 700	13.1	87	11 430	11.8	78	10.9	10.1	9.3	7.8	3.1	1.65	1.53	1.42	1.18	.47
12 600	13.0	86	11 340	11.7	78	10.9	10.1	9.3	7.8	3.1	1.63	1.52	1.41	1.17	.47
12 500	12.9	86	11 250	11.6	77	10.7	10.0	9.2	7.7	3.0	1.62	1.51	1.39	1.16	.46
12 400	12.8	85	11 160	11.5	76	10.6	9.8	9.1	7.6	3.0	1.61	1.49	1.38	1.15	.46
12 300	12.7	84	11 070	11.4	76	10.6	9.8	9.1	7.6	3.0	1.59	1.48	1.37	1.14	.46
12 200	12.6	84	10 980	11.3	75	10.5	9.7	9.0	7.5	3.0	1.58	1.46	1.36	1.13	.45
12 100	12.5	83	10 890	11.2	74	10.3	9.6	8.8	7.4	2.9	1.56	1.45	1.34	1.12	.45
12 000	12.4	82	10 800	11.1	74	10.3	9.6	8.8	7.4	2.9	1.55	1.44	1.33	1.11	.45
11 900	12.3	82	10 710	11.0	73	10.2	9.4	8.7	7.3	2.9	1.54	1.43	1.32	1.10	.44
11 800	12.2	81	10 620	11.0	73	10.2	9.4	8.7	7.3	2.9	1.54	1.42	1.31	1.10	.44
11 700	12.1	80	10 530	10.9	72	10.0	9.3	8.6	7.2	2.8	1.52	1.41	1.30	1.09	.44
11 600	12.0	80	10 440	10.8	72	10.0	9.3	8.6	7.2	2.8	1.51	1.40	1.29	1.08	.43
11 500	11.9	79	10 350	10.7	71	9.9	9.2	8.5	7.1	2.8	1.49	1.39	1.28	1.07	.43
11 400	11.8	78	10 260	10.6	70	9.8	9.1	8.4	7.0	2.8	1.48	1.37	1.27	1.06	.43
11 300	11.7	78	10 170	10.5	70	9.8	9.1	8.4	7.0	2.8	1.47	1.36	1.26	1.05	.42
11 200	11.6	77	10 080	10.4	69	9.6	8.9	8.2	6.9	2.7	1.45	1.35	1.25	1.04	.42
11 100	11.5	76	9 990	10.3	68	9.5	8.8	8.1	6.8	2.7	1.44	1.34	1.23	1.03	.42
11 000	11.4	75	9 900	10.2	68	9.5	8.8	8.1	6.8	2.7	1.42	1.33	1.22	1.02	.40
10 900	11.2	74	9 810	10.1	67	9.3	8.7	8.0	6.7	2.6	1.41	1.32	1.21	1.01	.40
10 800	11.1	74	9 720	10.0	66	9.2	8.6	7.9	6.6	2.6	1.40	1.31	1.20	1.00	.40
10 700	11.0	73	9 630	9.9	66	9.2	8.6	7.9	6.6	2.6	1.38	1.28	1.19	.99	.39
10 600	10.9	72	9 540	9.8	65	9.1	8.4	7.8	6.5	2.6	1.37	1.27	1.18	.98	.39
10 500	10.8	72	9 450	9.7	64	8.9	8.3	7.6	6.4	2.5	1.35	1.26	1.16	.97	.39
10 400	10.7	71	9 360	9.6	64	8.9	8.3	7.6	6.4	2.5	1.34	1.25	1.15	.96	.38
10 300	10.6	70	9 270	9.6	63	8.8	8.1	7.5	6.3	2.5	1.34	1.24	1.15	.96	.38
10 200	10.5	70	9 180	9.5	63	8.8	8.1	7.5	6.3	2.5	1.32	1.23	1.14	.95	.38
10 100	10.4	69	9 090	9.4	62	8.6	8.0	7.4	6.2	2.5	1.31	1.22	1.12	.94	.37
10 000	10.3	68	9 000	9.3	62	8.6	8.0	7.4	6.2	2.4	1.30	1.21	1.11	.93	.37

* Formula by C. H. Peabody, Extract XIII., A. S. of M. E., 1892.

per pound of coal, or for the total number of pounds of coal used for any given time, it is only necessary to know the total number of B. T. U. obtained from the coal for the same given time. Taking the following case as an illustration, supposing we had a 100 horse-power boiler, that is at a given test we obtained 100 horse power from the boiler by the evaporative efficiency; we would have 33 000×100=3 300 000 foot-pounds of work obtained. Joule's equivalent = 776 units = heat required to raise 1 pound water 1°, = elevation of 1 pound 1 foot high, or 1 pound 776 feet high. Unit of evaporation, to evaporate 1 pound water to steam at the pressure of the atmosphere=965.7 B. T. U. Therefore,

$$\frac{3\ 300\ 000}{776} = 4\ 252$$

heat units for 100 HP. 1°, and for 1 HP. 42.52 heat units, this multiplied by 60=2551.20 for 1 HP., or 255 120 H. U. for 100 HP. horse power per hour per pound of coal. In actual practice the cost of horse power varies from 1½ pounds of coal per hour to 3½ pounds; therefore, taking the mean of the two we have

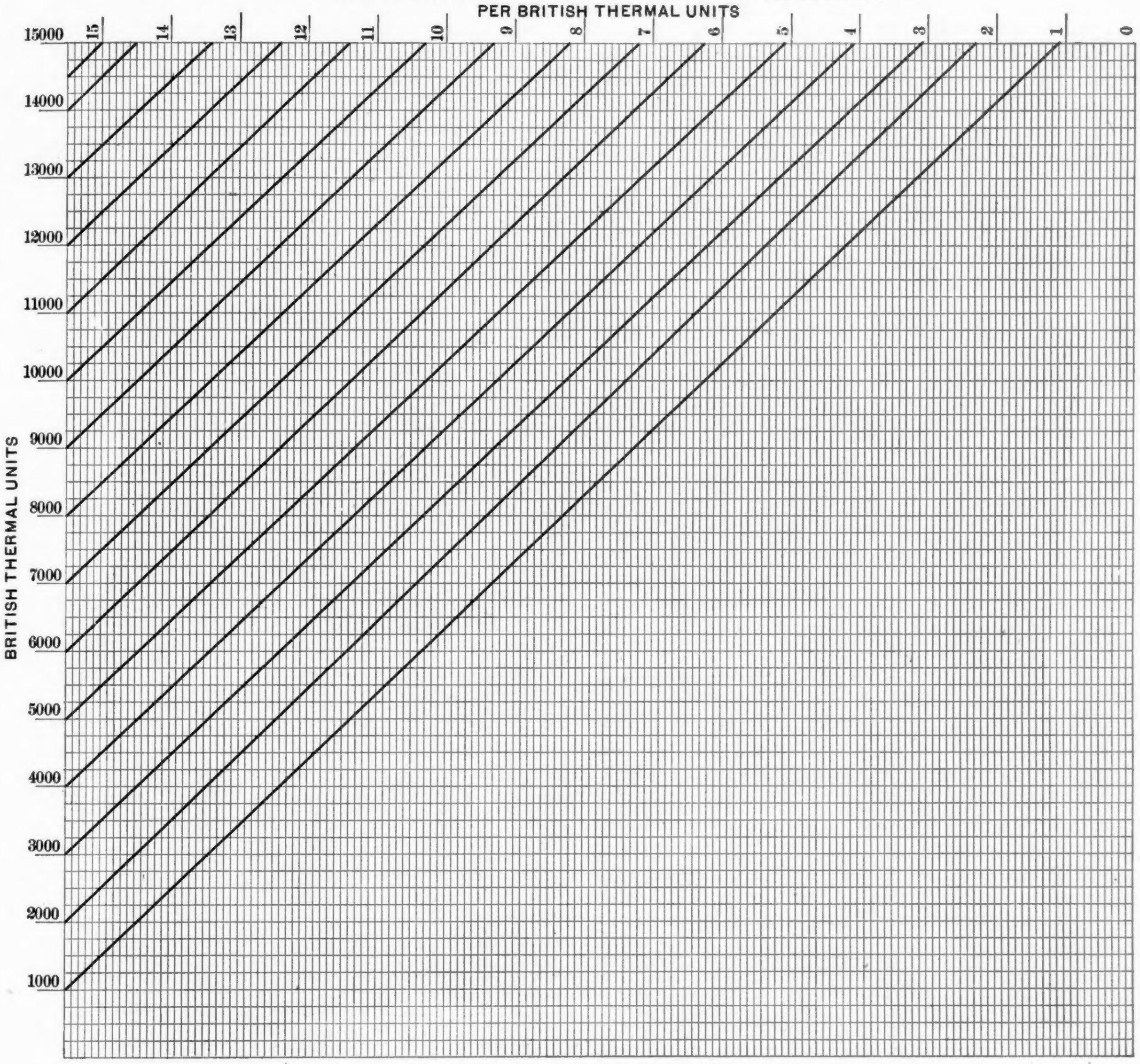
$$\frac{1.5+3.5}{2} = 2.5$$

as the average of the two for one horse power. So from above figures it will be observed that the theoretical figures are far from actual results obtained from practice.

EXPLANATION OF EFFICIENCY TABLE.

In connection with calculating the efficiency of boilers for different coal the writer has calculated an efficiency table, which is here presented in table No. 2. Referring to the table column No. 1 is the theoretical number of heat units contained in a pound of coal, this column shows the number contained in one pound from 10 000 up to and including 14 500; the 10 000, of course,

WATER EVAPORATED IN POUNDS PER POUND OF COMBUSTIBLE PER BRITISH THERMAL UNITS



per hour. And the number of pounds of water required per hour to generate one horse power is found by dividing 2551.2 by 965.7, which gives us 2.6 pounds for one horse power, or 260 pounds for 100 horse power. Of course the above is strictly theoretical, for as we have already mentioned here 30 pounds of water at 70 pounds steam pressure and 100° feed water is the standard for one horse power. Let us, however, continue with the above for the theoretical cost.

Anthracite coal has about 14 500 heat units per pound. Then dividing 14 500 by 965 gives 15 pounds of water evaporated per pound of coal. Therefore

$$\frac{2.6}{15} = .173$$

pounds of coal per horse power per hour, or

$$\frac{1}{.173} = 5.7$$

would be for an inferior grade of coal; the average grade of coal used would be about 13 000 to 14 000 heat units, anthracite coal would give the largest average, which in Pennsylvania runs from 12 200 to 14 199, calculated. Calorimetric tests of bituminous coal gives 12 941 for Youghiogheny, Pa. (lump coal), and same district for slack 11 664, but making allowance for ash we have 13 752 and 12 988 respectively. Semi-bituminous coal gives from 12 874 to 14 217 for total heat of combustion B. T. U. out of 10 tests. The calculation of a given coal theoretically from an elementary analysis is to some extent unreliable, and often gives results greatly at variance with an actual calorimetric test. Column No. 2 is the water evaporated from theoretical figures in pounds, from and at 212°, it is found by dividing the total number of heat units by 965.

Column No. 3 is the efficiency from one pound of combustible if all per cent. of heat units were utilized by the boiler. This, of course, is an impossibility, and is merely placed here to show the

theoretical value of perfect boiler performance, the top figure is, of course, 100 per cent. Column No. 4 is the probable number of heat units utilized by boiler, this also is theoretical figures, but applied in the correct manner may be very useful; if, for instance, we have a coal which has an actual calorimetric value of 14 000 B. T. U. and our boiler utilizes about 11 700 of the 14 000 units, which is about 83 per cent., we would, therefore, have an evaporative efficiency of about 80 per cent. of theoretical value, see column 6. In the above manner the different heat values may be applied to any boiler and for any coal. Column Nos. 5 and 6 go together, and they are the per cent. efficiency for probable number of heat units utilized by boiler, column 5 is the water in pounds evaporated per pound of combustible, and column 6 the per cent. of theoretical efficiency. If we utilized 11 700 heat units, column 6 shows that we have evaporated 12.1 pounds of water from and at 212°. This is quite high, a little larger than the average.

Columns 7, 8, 9, 10 and 11 is the equivalent evaporation efficiency per cent. over the theoretical units utilized to be added or subtracted to column 6. If, for instance, our boiler has actually evaporated 10 pounds of water per pound of coal, column 6 shows we have 66 per cent. from theoretical value; and if our boiler carries 131 pounds boiler pressure and feed water at 158°, we add 6.6 to 66, which gives a total of 72.6 per cent. efficiency. On the other hand, if the boiler has evaporated 10 pounds of water per pound of combustible from and at 212°, we will have an efficiency of 66 per cent., and if we wished to find the efficiency per cent. of actual coal evaporated per pound, we would deduct 6.6 from 66; this, of course, is low, but shows the three points of evaporation.

Columns 12, 13, 14, 15 and 16 are the equivalent evaporation efficiency per cent. over number of pounds of water evaporated per pound of combustible to be added or subtracted to column 5. The above five columns are treated exactly the same as just explained above for column 6. If our boiler has actually evaporated 10 pounds of water per pound of coal, and boiler pressure 131 pounds and feed 158°, we refer to column 15 and find 100 on the same row with 10, therefore the equivalent evaporation will be 11 pounds of water. Of course, the per cent. efficiency will be changed when taken at other places on the table as, for instance, our coal has 14 000 units and the boiler utilizes only 10 800, we therefore divide 10 800 by 14 000, this gives 77 per cent. efficiency, but the water evaporated would be, by referring to column 5, just 11.1 pounds per pound of coal.

A handy reference diagram is shown in a graphical method on Fig. 1. The vertical lines are all represented as tenths of a pound, and the number of pounds run from 1 to 15½. The horizontal lines represent the B. T. U. and are graduated 250 units from one line to the next. The diagonal lines indicate at a glance just the number of pounds of water evaporated for a given number of heat units. As an example: referring to diagram, the left-hand column shows number of B. T. U., how many pounds of water will 12 000 B. T. U. evaporate, running up the heavy diagonal line we have just 12.4 pounds of water. To count the pounds of water, count the whole number of pounds of water nearest to the diagonal line, which in this case is 12, and then count the spaces between the line representing the whole number and the diagonal line, this proves to be 4, consequently this gives us 12.4 pounds of water. By referring to the table the second column also gives the same amount. If we wished to find the number of pounds of water for any fractional number of B. T. U., say 10 250, take the first line above the 10 000 mark, and draw a line parallel with the diagonal line, and where it intersects with the top horizontal line will give the number of pounds of water evaporated for the required B. T. U.

* * *

DRAWING ROOM HINTS.

MANILLA AND SECTION PAPER—TRACINGS.

Chas. L. Griffin.

Most drafting offices are committed to the use of certain varieties of paper for the different classes of work. Manilla paper is quite universally used for sketching and preliminary work, while for more exact or finished work a good quality of drawing paper is used, or perhaps bond paper, in which case no tracing is necessary. I have used with success for several years a white paper known as ledger paper, which can be bought of almost any weight required. It comes by the ream in sheets 21 × 32 inches, is of low cost and serves equally well for rough or finished work. For rough work and sketching, a valuable modification can be made by having the paper ruled into one-eighth inch squares. This costs but little extra and will more than pay for itself in time saved. I used to feel a slight prejudice both against the kind of paper and the sectioned surface, but found that it was merely a prejudice for not only myself, but every man whom I have seen become accustomed to it prefers it to any other paper. The incidental advantages of it are that it is a very convenient size as it comes, and will cut into sheets 16 × 21, which my experience has shown is a very desirable size for shop prints. The sectioned surface, besides being a useful designing accessory, affords a ready device for hastening work to the pattern or forge shop. Many concerns use ruled paper, but it is usually restricted to scratch-block size, and is useless for "layouts" of any extent. An expert man will hustle drawings into the pattern shop at a great rate on this paper without the use of triangle or T-square, or even tacking it to the board.

I wonder how many shops have extended the check system to the keeping of shop blue-prints. If there are but few who have adopted it, and I think such is the fact, then a most useful device does not have the prominence it should in shop management. In brief, the system is that every blue print in the shop has its headquarters in the tool room, and is replaced by the workman's check when taken out. There is more of value in this scheme than is at first apparent. The workmen are responsible for the prints and the nuisance of lost or misused prints is avoided. If a change becomes necessary no time is lost in placing the hand on the required print at once. The tell-tale record board of the tool-keeper shows the number of prints in the shop, and in case of replacing them there is never any fear of leaving an incorrect print for somebody to read in error. For the perfect realization of the benefits of this system, a duplicate set of prints should be provided for the general shop foreman. These should be bound up or classified by him as best suits his convenience, and always kept by his desk in suitable drawers or shelves. The whole problem of the division of his shop work is thus always at hand, and he may study methods, make any notes he chooses on the prints, in other words use them as personal memoranda of the work he has in charge. There is no useless red tape to the system. It is simply a running record which enables everybody to know the most about the work in hand with the least trouble.

Speaking of blue prints, I notice that a correspondent under the title "Machine Drawings for the Shop," says "tracing cloth should never be used, for it cannot be kept in good condition to get blue prints." I am interested to know what your correspondent does to his tracing cloth which makes it unfit for taking blue prints. The remark reminds me of the performance of an apprentice whom I once requested to take a tracing from the frame, where it had been exposed over the sensitized paper. He took out both paper and tracing cloth, but he threw away the former and soaked the latter, rendering as an excuse that "he had never tried to make blue prints before, any way." I have used both bond paper and tracing cloth for ten years or so, and think they should both be found in every office. Tracing cloth will stand anything but soaking, but I don't know about the bond paper.

* * *

THE CONDENSING STEAM ENGINE.—2.

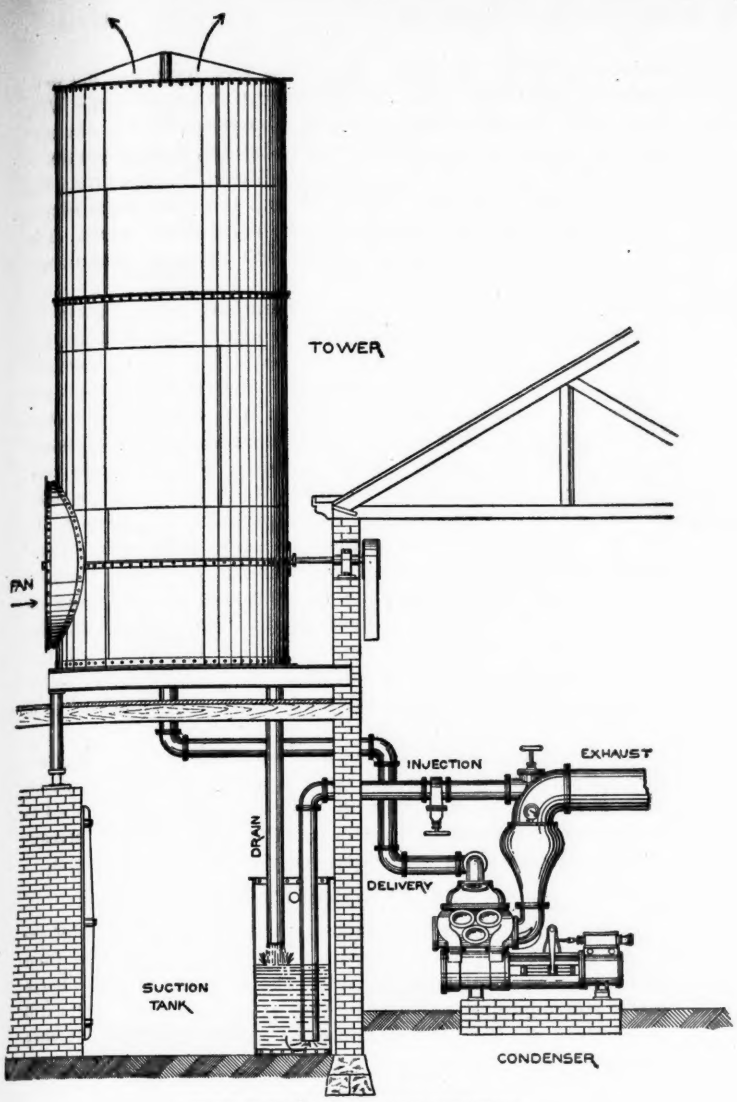
STARTING UP A CONDENSING ENGINE, WITH AIR-PUMP.

F. F. Hemenway.

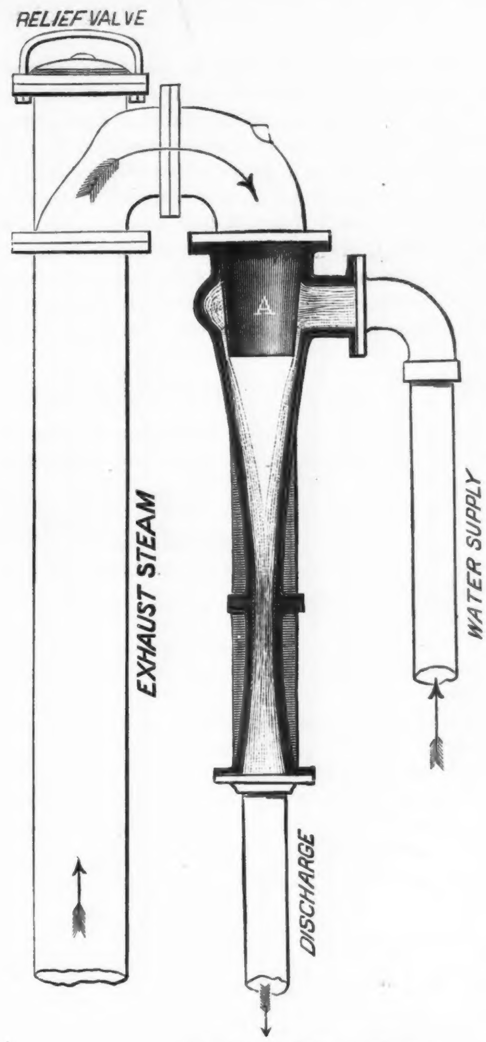
In starting up a condensing engine the precaution to proceed rather slowly should be observed. First let the engine make a couple of turns, then open the injection cock gradually, so as not to gorge the condenser or air pump, increasing both steam and injection until the engine is in regular operation.

OTHER MEANS OF CONDENSATION.

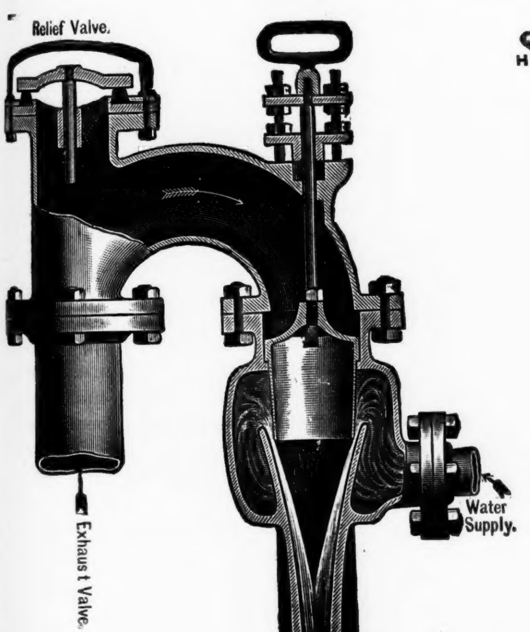
Various means of condensation are employed in which no air-pump is used, such as injector and ejector condensers, and the like, some of which give good results. In some of these it is necessary that the hot well be at least 34 feet below the condenser, while in others this is not necessary. But, as previously intimated, the engineer must take the condenser he finds with the engine and make the best of it. What has been said in relation to tight joints everywhere, applies with the same force to



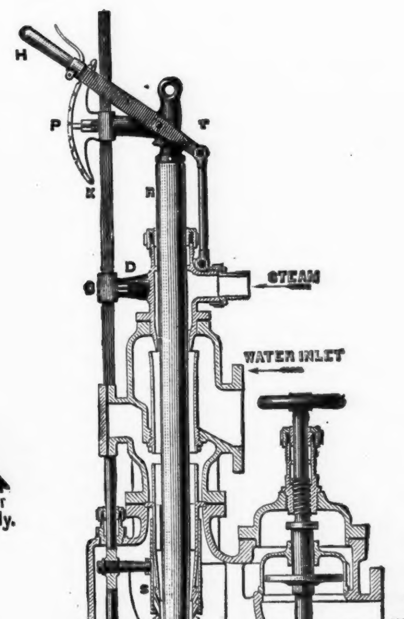
WORTHINGTON'S SELF-COOLING CONDENSER.



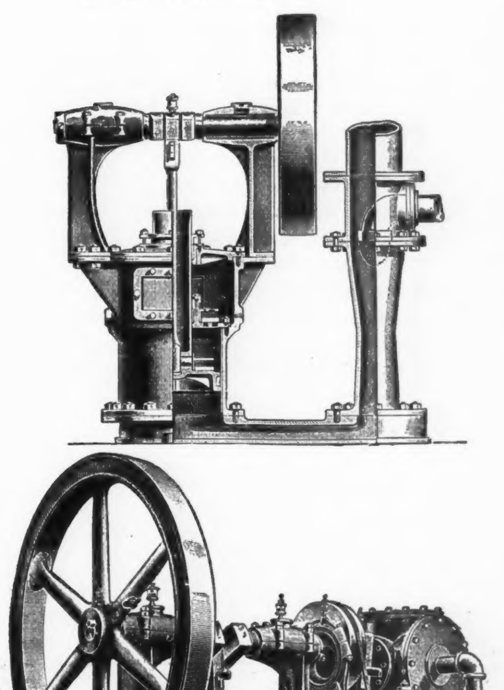
BULKLEY INJECTOR CONDENSER.



BARAGWANATH'S WATER JACKET CONDENSER.



KORTING EXHAUST STEAM INDUCTION CONDENSER.



CONOVER MFG. CO.—INDEPENDENT CONDENSER.

THE CONDENSING STEAM ENGINE.

these types of condensers. No air leaks are admissible, and in relation to the siphon condensers the end of the discharge pipe must always be submerged in the water of the hot well.

Here, Fig. 4, is an old condenser invented in about the year 1825 by Alban, a German engineer. I do not know to what extent it was ever used, how well it worked, or whether it is anywhere in present use. The condenser consists of a sheet copper pipe *b*, situated in a cistern of water *c*, which is supplied through the pipe *k*, *i* being a strainer. The exhaust steam enters the condenser through pipe *a*. An emptying cock *l* is provided. The injection is at *m*. When exhaust takes place the flap valve

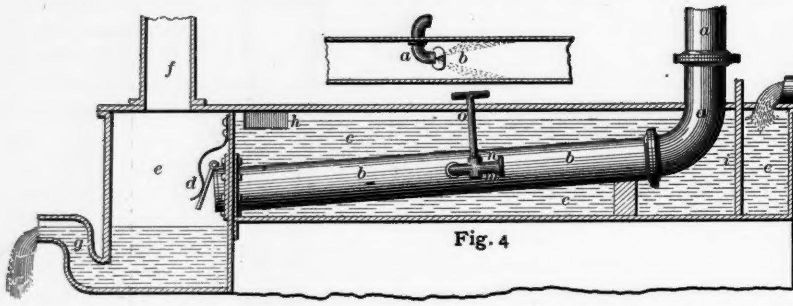


Fig. 4

d is opened, but immediately closes and water again enters the condenser.

I do not show this condenser as in anyway recommending it, but rather as a curiosity. It shows one of the ways of getting around the use of the air-pump. The inventor was the manufacturer of an engine that was, for the day, operated with high pressure steam, and evidently thought, for some reason, that an air-pump (perhaps owing to high speed) could not be worked in connection with it. This arrangement, he claimed, worked satisfactorily.

The Bulkley Injector Condenser* is one of the type referred to as requiring no air-pump Under certain conditions it may be operated entirely as a siphon condenser. The condenser is located at a height of 34 feet above the water level in the hot well. The condensing water enters at the side and is spread into a thin annular film. The exhaust steam enters this hollow core of water and is condensed. The cut is so clear that those interested may study it all out. The relief valve will open provided the vacuum is lost, allowing the engine to go right along, exhausting into the atmosphere.

Another condenser of this type is called the Water Jacket Condenser. I suppose it to be the invention of Wm. Baragwanath†. Like the condenser just referred to, this should be set at about 34 feet above the water level in the hot well. The relief valve is for the same purpose as previously mentioned. There are what I should presume to be some important improvements in this condenser, one being an adjustable nozzle. If the water opening becomes clogged, this nozzle can be raised so as to flush out the obstructing material, then returned to correct position. Again the water can be varied so as to admit just the right quantity to the

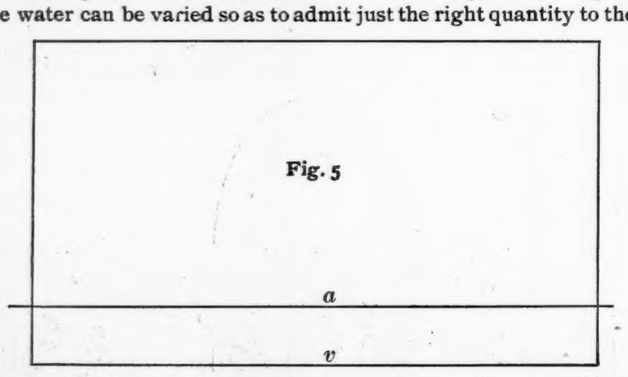


Fig. 5

condenser. Either of these operations can be performed without interfering with the operation of the engine. The condensing chamber is jacketed by the entering water for condensation, so as to assist in keeping the chamber cool.

No special care is required in starting up an engine fitted with either of these condensers. At the same time the engine is started give condensing water gradually. See that all joints are kept tight, and that the pipe extends nearly, but not quite, to the bottom of the hot well.

As has been intimated, there are condensers for which no air-pump is required, nor water column 34 feet high, nor hot well, such as the Korting exhaust steam induction condenser‡. With this water may be lifted 15 feet if necessary. When the condensing water has to be lifted before starting, a little live steam is admitted at the opening marked "Steam." This brings the water to the condenser. After starting, this live steam supply can be shut off, the exhaust steam being all-sufficient. The engraving is so clear that the "all-alone evening" student will master it.

I want again to say that these illustrations are not given for the purpose of describing the machines which they illustrate, but to give points to those who are home students.

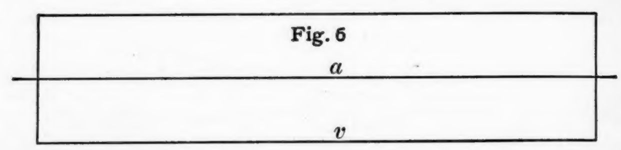
It has been stated that the condenser is of more consequence in the instance of low pressure than in the instance of high pressure steam. Figs. 5 and 6 will illustrate this. Although not actual indicator diagrams, they may be taken as representatives of such. In either, *a* is the line representing atmospheric pressure and *v* the line of vacuum. The gain from vacuum is represented by the space between the lines *a* and *v*. In Fig. 5, where the steam pressure, represented by the upper line, is fairly high, it will be observed that the gain by condensation is, while actually the same, relatively much less than in Fig. 6, where the pressure is low.

The distance apart of the lines *a* and *v* should be kept as great as possible without using too large a quantity of water, which leads to the observation that an indicator should be applied to see how great this distance really is. For the lack of this precaution engines have run wastefully—very wastefully—for years.

CONDENSATION BY AIR

In some localities it is impracticable to obtain the water required for the proper condensation of the exhaust steam from steam engines. Take, for example, the instance of a 500 horse power steam engine, and assume that 45 000 gallons of water will be required per hour for condensation purposes. This is a very

Fig. 6



considerable quantity of water. The cost of it in some large cities would make the use of a condensing engine out of the question—an engine requiring that quantity of water.

I place the quantity required at 90 gallons per horse power per hour, because, while some engines will use less than this quantity, others will use more, and all will require more than calculation will call for. Aside from large cities there are many other places where it is not possible to obtain this quantity of condensing water without an expenditure that is prohibitory.

For this and for other reasons efforts, some of them attended with more or less of success and others with palpable failure, have been made to bring air into service as a condensing medium. Very many of the arrangments for this purpose have been of a make-shift character, but the one I use for the purpose of illustration partakes of the nature of a machine. It is termed a self-cooling condenser, by the manufacturers§.

With this condenser the exhaust steam is condensed by water from the suction tank, the warm water of condensation being cooled in the tower, passing from the top downwards to the suction tank, from which it is used over and over again.

At one side of the tower is a fan, which has for its purpose the circulation of air through the filling in the tower, this filling consisting of cylindrical tubular tiling in comparatively short lengths, their arrangement being such that a tiling in one row rests on two or three in the row next below. This arrangement breaks up direct currents of both steam and water, and with the distributor at the top of the tower, which distributes the water over the upper section of tubes and interstices, the air and water are brought into intimate cooling contact.

The heated water in its passage by gravity through the tower is cooled by radiation, the contact of cool air and by evaporation.

A condenser of the air type, when properly arranged, makes

* Henry W. Bulkley, New York.
† Wm. Baragwanath & Son, Chicago, Ill.
‡ A. Aller, New York.
§ Henry R. Worthington, Brooklyn, N. Y.

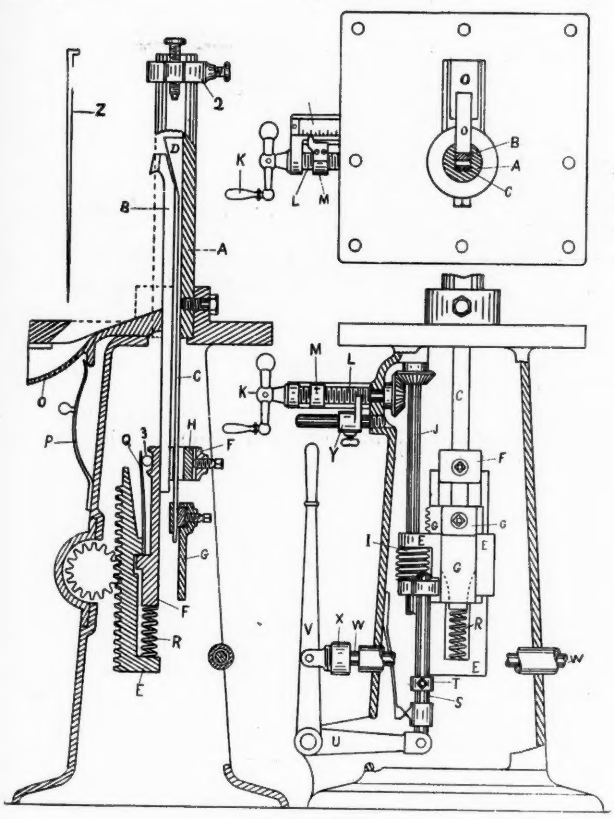
a very effective arrangement, air being an excellent cooling medium. Either jet or surface condensation may be employed.

AN INDEPENDENT STEAM-DRIVEN CONDENSER.

Reference has been had in the preceding issue to the growing popularity of independent condensers. The subject is renewed by the production of two cuts, kindly loaned by the manufacturers,* and which I hope will serve the purpose of keeping up the interest of the younger readers of your paper in this important branch of steam engineering. The engravings represent the arrangement for engines up to 2 000 HP., except that the driving may be by belt instead of by supplementary engine if desirable.

The air pump is situated at the left, the condenser at the right and the engine at the center. The engine is of the Corliss type, with the exception that the point of cut-off is fixed, the proper speed being maintained by the operation of a throttling governor. The engine is compound condensing, which fact serves to answer the question: What is the advantage of having facilities at hand if you don't use them?

The sectional view of air-pump and condenser will explain itself to those who are interested, the two views making plain the whole arrangement. It will be observed that the air-pump is of the trunk pattern, doing useful work on its stroke in one direction only, and that the engine takes steam from the boiler but once during a complete revolution. By a proper location of the relative angular positions of the air-pump and engine cranks, and a



A NEW KEY-SEATER.

suitable adjustment of cut-off on steam cylinder, the work being done and the power doing it, can be so nearly balanced throughout the stroke as to avoid the necessity for the employment of a fly-wheel of more than moderate proportions.

For powers greater than 2 000 HP. the condensers are made with two air-pumps.

RECAPITULATION.

To summarize: See that every joint and valve around the condensing apparatus, no matter what that apparatus may be, is tight.

Use the least quantity of condensing water that will maintain a good vacuum, especially if this water has to be handled by a pump.

In starting up, avoid giving injection with precipitation; do so with moderation so as not to gorge the air-pump.

Take as good care of the condensing apparatus as of any other part of the engine.

* * *

A NEW KEYSEATER.

The economical cutting of key-seats has long been a problem for machinists, and many machines have been made to do this work. Most of them, in fact all except the Giant machine, are said to require the hub trued up before cutting key-seat But there is plenty of work, such as mowing machine parts, which require key-seats, but not the hubs faced off.

With the ordinary machine the hubs must be faced whether you need it or not, else the key-seats cannot be cut on the machine. This means useless work—money thrown away. As to speed, it is stated that a key-seat 6 inches long and ½ inch wide and ¼ inch deep can be cut in two minutes, including time of putting on and taking off the machine. The section view makes the operation clear.

The post A is grooved to receive tool bar, is made of right size for the work in hand and can be readily changed for any size work. The power is applied through the medium of a double reduction gear, and the pinion shown drives the crosshead E, which drives the cutter-bar B through the flexible connection shown, the motion being reversed automatically by tappet rod and tappet S and T, or can be worked by lever V. The feed is obtained by drawing down the wedge D behind the head of tool bar, the wedge being operated by the handle K through the medium of the bevel gears and screw I, which act on wedge-bar holder G; a movement of the indicator one inch on the scale N showing a depth of ¼ inch in keyway, so that accurate and duplicate work can be done, the stop Y being set to prevent the index from going too far.

Q. & C. PORTABLE SAW.

An ingenious feature is the spout O which conducts away the chips, and being pressed against the tool bar by the spring P, holds it back in position on the up stroke. When taper keyways are required the wedge Z is fastened to post A behind wedge bar D.

Attachments are also made for cutting keys as well as keyways. Anyone having this class of work and who is tired of the expensive cold chisel and hammer method, should correspond with the makers, Mitts & Merrill, East Side, Saginaw, Mich.

* * *

Q. & C. PORTABLE SAW.

These are substantially constructed yet light enough to be easily transported on a hand car. The following letter from a roadmaster speaks volumes for its usefulness:

"We have had the saw six months and have made over 100 cuts with it. For repairs it has cost $1.00 for sharpening two blades and 80 cents for a new handle. We have made the cuts in from 9 to 15 minutes, an average of 12 minutes per cut. The saw can be operated by two men. The advantage is that any length can be cut from ⅛ inch up, and rails can be cut in track as well as out. Where slip switches, frogs or crossings have been crowded ahead by reason of creeping track, we have been able to cut out an inch or so without removing the rails from

* Conover Mfg. Co., New York.

track, shove the switch or frog back and put it in good shape, making a first-class job of it, without the use of another rail to cut or any unnecessary expenditure of labor. Without the saw it would have been necessary to get another rail to cut, remove the long rail from track and substitute the cut rail. This would have involved the expenditure of four times as much labor as was required with the aid of the saw. We have also cut off stub switch rails in the track which had been tight on account of expansion, finishing the job in 30 minutes without removing a rail or rod. Without the saw it would have been necessary to cut other rails and exchange them and would have taken four times as long, with a corresponding increase of labor and a poor job when done.

"On new work we find it a great advantage to cut lead rails so that switch points will be opposite and not one ahead of the other, as is the case when regular lengths are used. For special jobs we have been able to cut switch rails where we had to use 12 foot switch to accommodate the lead. Without the saw the switch would have been sent from storehouse with the attending delay. Last fall when I received an order to put in nine switches I lacked the material and could not get it, but with the saw I was able to work up some 4½ inch scrap rail and thereby got the switches in within the desired time. We could not have done this without the saw.

"The economy in using the saw is that rails can be cut in track, that there is little waste, as very near the desired length can be used, as the saw will cut ⅛ inch as readily as 6 feet.

"From my experience I consider it economical on any division where there is anything like the quantity of cutting that there is here, and would particularly recommend its use on all new work where any cutting is to be done."

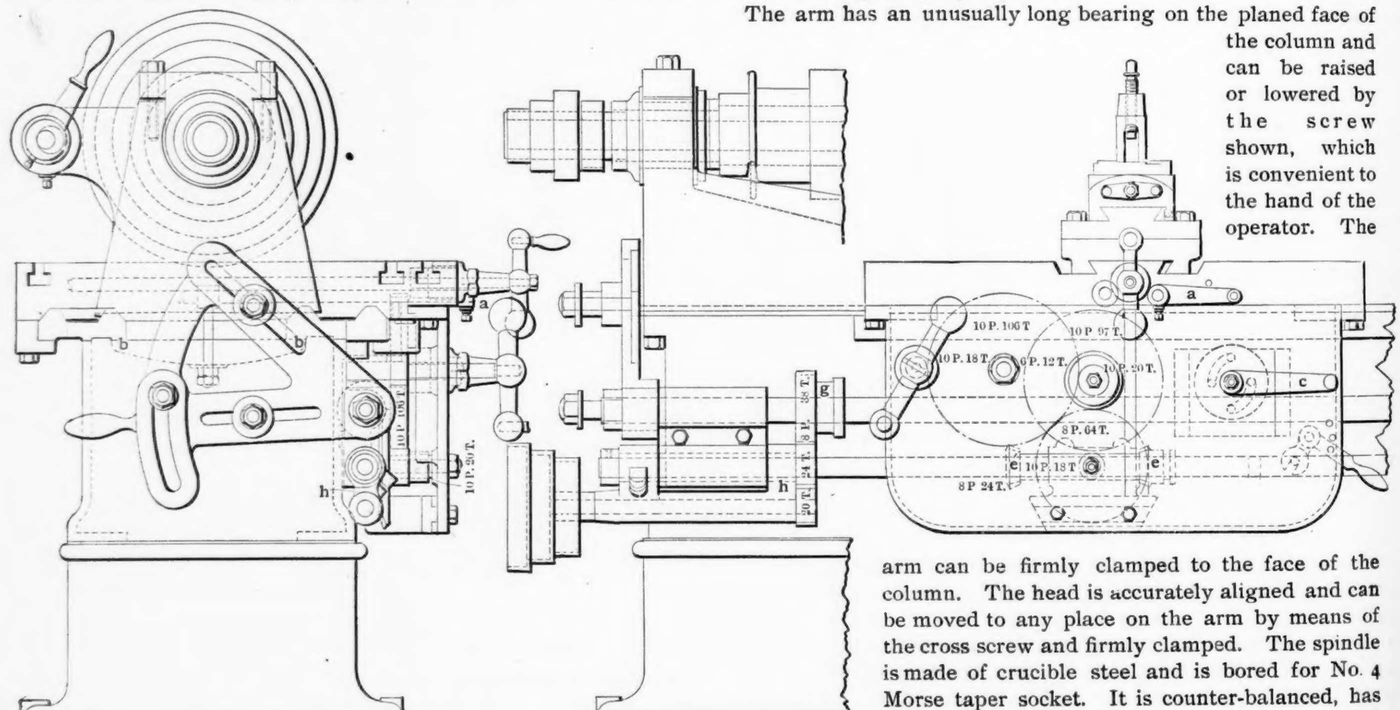
* * *

A HEAVY LATHE.

This tool, of which we show a few details, is a new 26-inch engine lathe recently brought out by Dietz, Schumacher & Boye, of Cincinnati, Ohio. Iron has not been spared, and as a result the lathe is heavy and rigid, yet the carriage is conveniently handled and has several good points. When facing a rough piece the carriage is very apt to spring back away from the cut, and the single screw or clamp frequently provided is not a satisfactory lock. In this lathe the lever *a* moves a rod with an eccentric at center of bed and locks the carriage by drawing the clamp or strap *b b* up against the lathe bed, locking it solidly.

The engraving shows the lathe-bed broken, in order to show the carriage and swinging cone bracket on bed.

Lever *c* controls the threaded nut, as is usual, and neither feed nor screw can be locked in place until the other is released. The feed is reversed in the apron by lever *d*, which throws the bevel



A HEAVY LATHE.

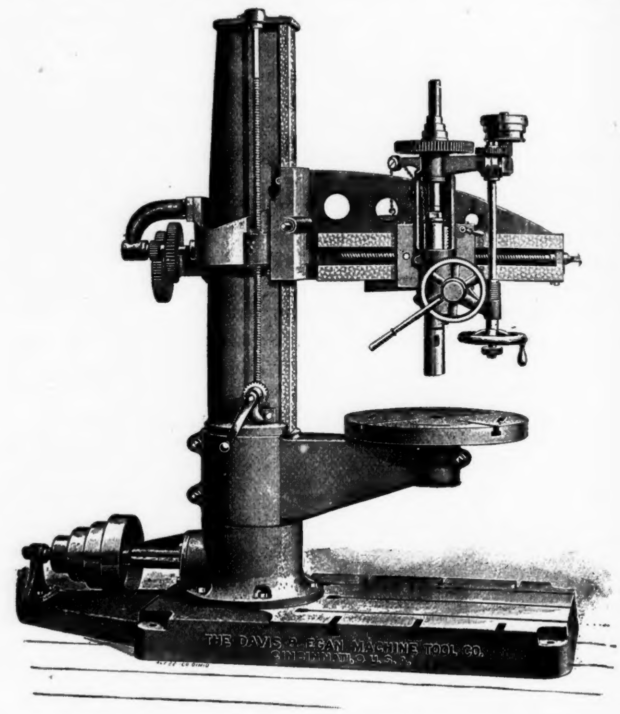
pinions *e e* in and out of mesh with the large gear. Power cross-feed is controlled by *a* knob being in or out. Pinion *g* is splined to the lead-screw rod and allows the feed rod to be driven by the gear train if desired, or by the belt feed, as may be found best for the work in hand. Another useful feature in this connection is having the lower feed cone and box hinged to bed and capable of being swung so as to keep the belt tight without cutting and lacing.

It will be noticed that the carriage has been carried above the tool-block ways so as to leave metal enough above the generous T slots for bolting down work. Every part of the lathe appears to be very rigid and capable of doing heavy work.

* * *

COMBINATION RADIAL DRILL.

The column of the 60-inch Radial Drill here illustrated is of the hollow box girder type and revolves in anti-friction bearings in



the stump, to which it is closely fitted and which is firmly bolted to the base. The arm carrying the table also revolves about the outside of this same stump, and by a novel arrangement can be clamped to it without clamping the column, or they can all three be clamped rigidly together.

The arm has an unusually long bearing on the planed face of the column and can be raised or lowered by the screw shown, which is convenient to the hand of the operator. The arm can be firmly clamped to the face of the column. The head is accurately aligned and can be moved to any place on the arm by means of the cross screw and firmly clamped. The spindle is made of crucible steel and is bored for No. 4 Morse taper socket. It is counter-balanced, has power feed with three changes and is furnished with a quick return. The feed belt can be tightened without cutting. The drill is driven by a four speed cone mounted on double bearings near the base of the column, giving eight changes of speed with the back gears engaged. It is strongly ribbed and has ample T-slot for clamping work. The machine is built by the Davis & Egan Machine Tool Co., of Cincinnati, Ohio.

MACHINE SHOP ARITHMETIC.

A series of practical articles clearly explaining the portions of mathematics which will be useful to the men in the shop and engine room.

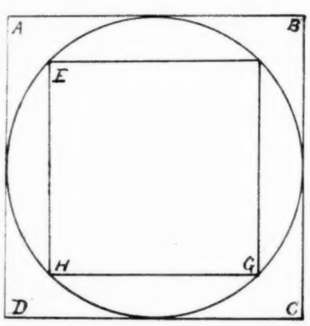
PRACTICAL QUESTIONS CONNECTED WITH THIS SUBJECT WILL RECEIVE PROMPT ATTENTION.

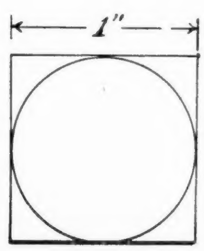
HANDY MULTIPLIERS.

CALEB TOPHAM.

Diameter of circle	× .88623	= Side of square having equal area.
Circumference of circle	× .28209	= Side of square having equal area.
" " "	× 1.1284	= Perimeter of square having equal area.
Diameter of circle	× .7071	= Side of square drawn within the circle.
Circumference of circle	× .22508	= Side of square drawn within the circle.
Area of circle	× 1.2732	= Area of square whose side equals diameter of circle.
Area of circle	× .63662	= Area of square drawn within the circle.
Side of square	× 1.4142	= Diameter of circle drawn outside of square, touching its corners.
" " "	× 4.4428	= Circumference of circle drawn as above.
" " "	× 1.1284	= Diameter of circle having equal area.
" " "	× 3.5449	= Circumference of circle having equal area.
Perimeter of square	× .88623	= Circumference of circle as above.
Square inches	× 1.2732	= Equivalent circular inches.

After understanding the use of these multipliers they are great





time-savers, and while anyone who makes many calculations of a similar kind should have multipliers for his own particular work, these are handy for occasional use if kept in a convenient place. In most instances the uses of each multiplier is explained at the right, but it may be well to give a few practical examples to prevent any mistakes. In all cases the first dimension is considered as 1, and the first case can be taken to read that a circle one inch in diameter equals in area a square having sides .88623 of an inch long, or having a round smoke flue 20 inches in diameter, and wishing a square one of the same area we multiply 20 by .88623 and find the square flue must be (20×.88623) 17.7246 inches on each side. It must also be remembered that this relation holds good whether it is one inch or ten miles. The method is exactly the same should the circumference of the circle be given instead of the diameter, using the given multiplier. It will be noted that the difference is due to dividing .88623 by 3.1416, the ratio existing between the diameter and circumference of a circle. The perimeter of a square is the distance around it, the same as the circumference of a circle, the difference being an attempt to avoid confusion, although the boundary of a circle is sometimes called its perimeter as well as circumference.

This multiplier shows that the circle contains the greatest area for a given boundary, as the square has 1.1284 times as much, or calling the circumference of a circle 10 inches, the perimeter or outside surface of a square of equal area will be 10×1.1284 or 11.284, and as this is the sum of all four sides, *one* side must equal ¼ of 11.284 or 2.821 inches. This shows that a round tube or pipe presents less surface for condensation or transmission of heat than any other shape of equal area.

An inscribed square is one drawn within a circle (usually), so that its corners touch the circle as E F G H in figure 1 An every-day example is the square reamer at work in a round hole. It is evident that the *side* of this square must be less than the diameter of the circle and also that the *diagonal* or hypothenuse of the square (distance across corners) must just equal the diameter of the circle. Knowing this, we could find the side of the square by the usual methods, *i. e.*, extracting square root of half the square of hypothenuse, which in the case of a square will give the length of one side. Instead of this we use the multiplier given, and calling the diameter of our circle 9 inches, we multiply by .7071 and get 6.3639, which is practically the same as saying $9 \times 9 = 81$, $81 \div 2 = 40.5$, $\sqrt{40.5} = 6.3+$, and is much quicker and easier. If we have the circumference instead of diameter of circle given use .22508 as the multiplier, it being .7071 divided by 3.1416.

It is often desired to know the comparative areas of circles and squares having the same diameters, or in other words the diameter of a circle which equals the side of the square. Taking the multiplier from the table we find that the area of square will be 1.2732 times that of the circle, or with a circle of 100 square inches area, a square whose side equalled the diameter of circle would be 100×1.2732=127 32 square inches in area. This would be called a circumscribed square, as A B C D in Fig. 1, this being drawn around the circle shown. Taking the area of a circle as 100 square inches as before, and wishing to find the area of an inscribed square, as E F G H, we multiply the 100 inches by .63662 and get 63.662. It will be noticed that this is just one-half the area of a circumscribed square, which it may be well to remember. The next five multipliers need little or no explanation; the details at the right give about all the necessary information.

The last multiplier may puzzle some a little, especially if they have never run up against the "circular inch," instead of the square inch. It is used in calculations of round pipes or columns, and means the area of a circle 1 inch in diameter. For example, a pipe 12 inches in diameter would be said to contain 12×12=144 circular inches, or 144÷1.2732 square inches. Then we see that a pipe or flue 12 inches square would have 12×12=144 square inches, or 144×1.2732=183.34 circular inches. You may not have much use for these, as they are not generally used, but when you hear a man talking glibly about circular inches, its quite a satisfaction to know what he means even if you don't use it.

* * *

TWO CLASSES OF INVENTIVE FACULTY.

The ability to invent an appliance, and that to devise the processes or the appliances for its satisfactory production at a profit on a commercial scale, may be said to be entirely separate faculties. Many an inventor who has an excellent idea is greatly handicapped by utter inability to produce his invention at a price which would command (or even open) the market and yield a profit. *Vice versa*, many a man who has saved thousands of dollars for his employers or his customers by producing their inventions well and cheaply, by ingenious appliances and methods, has never evinced in the slightest degree what is usually known as inventive ability.

It may also be noted that the ability to invent a machine for the production of a special simple product (as a pin) is entirely distinct from that for carrying on successfully the manufacture and assemblage of separate parts of machines. The one calls solely for mechanical ability, such as would also be exhibited in

the invention of a calculating machine, or a telescope; a delicate standard balance, or a "millionth" measuring machine, which might be produced in absolute perfection at enormous cost, and find no sale. The other demands a knowledge of the qualities of materials alone and in combination, with regard to their manufacture or wear, and of the time and expense required to produce a given result with each shape of piece in each kind of material.

The sewing-machine mechanic and the watch mechanic exhibit in the highest degree this kind of "commercial mechanical ability." which enables what are really instruments of precision to be made and sold by hundreds of thousands at prices which bring them within the reach of nearly all whom they would benefit. G.

* * *

HOW AND WHY.

A COLUMN INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST. GIVE ALL DETAILS AND YOUR NAME AND ADDRESS, WHICH WILL NOT BE PUBLISHED UNLESS DESIRED.

57. A. L. R. wishes to know if there is any truth in the statement that steel corrodes faster than iron. *A.* We know of no better answer than the following from *London Fairplay:* "A steel manufacturer made a number of experiments to test whether it really was the case that steel corroded more quickly than iron. The experiments were carried out by means of plates of various thicknesses being exposed in both fresh and salt water for periods from one month up to a couple of years, with the result that the steel plates exposed for a period up to six months corroded much faster than the iron ones, but after that the advantage lay with the steel, those exposed for two years being in a much better condition than the iron ones. Another thing learned was that ships built of steel within the last few years do not show the same inclination to corrode, from the fact that the manufacture of steel is better understood."

58. R. A. D. asks: What is absolute zero and how was it determined? *A.* Air at 32 degrees Fahr. shrinks $\frac{1}{492}$ of its volume for each degree of cooling below 32 degrees. This indicates that it could shrink 492 degrees, and this is 460 degrees below our freezing point, 32 degrees. Then when we speak of boiling water as 212 degrees above zero, it is in reality 212 plus 460, or 672 degrees above absolute zero.

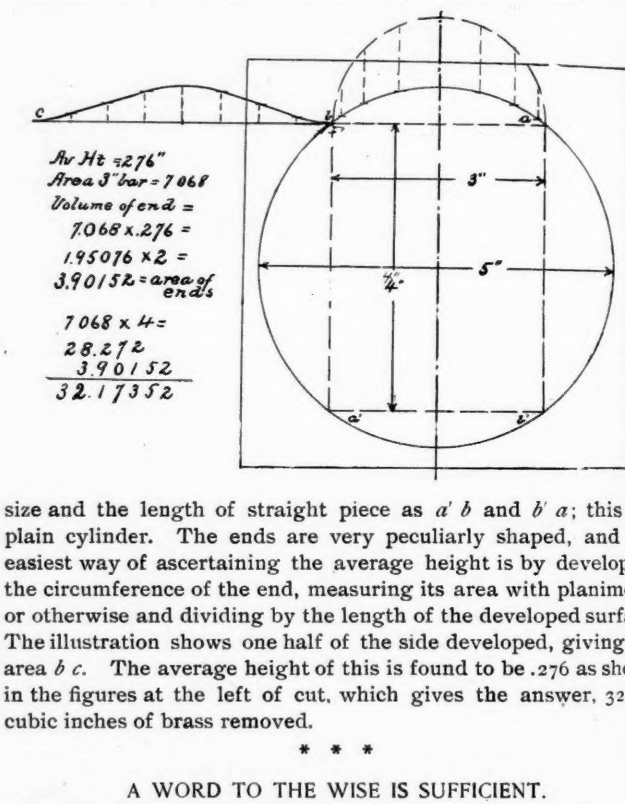
59. W. T. S., Salem, N. C., inquires about hydraulic rams 12 inches in diameter to carry a load of 350 tons or 6 196 pounds per square inch. *A.* We refer him to the articles on pages 320 and 321 of the present issue.

60. J. Y. T. wishes to know the proper speed for turning wrought iron in the lathe? *A.* Authorities differ, and the kind of work also affects the speed. The maximum speed for turning wrought iron is given at 40 feet per minute; approximately, 40 revolutions for a 4 inch piece. Machine steel is given as 14 feet, although this is low, and with fairly soft steel 20 or even 25 feet is not excessive. The makers of the Jones & Lamson flat turret advise speeds of from 10 feet for tool steel to 60 feet for wrought iron. The main question is to prevent the tool heating and losing its temper, and means for keeping the point cool either by oil, water or air blast, will increase its cutting capacity. 2. What is the best pressure for forcing pins in cranks, etc., by hydraulic pressure? *A.* A very good practice is to allow six tons per inch of diameter when the pin and hole are both true; it may be necessary to increase this where the pins are not true, to eight or possibly ten tons per inch of diameter.

61. A. L. C. wishes to know of a method for whitening small brass castings. *A.* We are informed by one familiar with the pin business that his method is to dip the pins (brass) into a solution of argol and pure tin. The solution is boiled four hours and the test for strength given is that it shall taste quite tart. A little experimenting is said to give the desired results.

62. L. A. W., N. Dakota, writes: (1.) Suppose we have a valve gear which cuts off sharply at one-eighth stroke, then open again at half stroke, closing quickly (say at five-eighths stroke). Would it not reinforce the steam, heat the walls for the next admission of steam and be a saving? This only in a compound engine, of course. *A.* This would not be as economical as using the same amount of steam ($\frac{1}{4}$ stroke in all) at the beginning, or using the second admission in a steam jacket. One-eighth is too short cut off for ordinary practice. The second admission would of course reinforce the steam in cylinder, but in an expensive way, although not so much so in a compound as in a simple engine. (2). Your second question is based on an erroneous idea of the question of angularity of connecting rod. The crank is not accelerated and retarded, but is kept at constant speed (within very close limits) by the fly-wheel action. It is the piston that is accelerated, not the crank. (3). The idea in giving compression is not, except in a few instances, intended to place the terminal pressure on a parity with the initial pressure. The terminal is the pressure at which the steam exhausts. You, of course, mean that compression should equal initial pressure, but while this is advocated by some, it is not general practice. The main object of compression is to ease the engine over the center, prevent pounding, etc., and it also warms the walls slightly for the next influx of steam. The work of compression is not all lost, a portion being returned in head added to cylinder walls, and its expansion aids the piston in case of late admission. (4). Why are steam ways made so long and crooked in some engines? *A.* This question is overlooked in too many cases, in others the valves or other feature of design will not admit of short, straight ports, which are desirable.

63. M. T. S. asks: 1. Taking a cast iron block of indefinite size and put a 3 inch brass bar through it. At right angles to this a hole 5 inches in diameter is bored; how much of the brass is removed? *A.* In the illustration below, the 5 inch hole is shown and the 3 inch bar in dotted lines, as indicated by the dimensions. The easiest way is to lay this out on paper, full



size and the length of straight piece as *a' b* and *b' a*; this is a plain cylinder. The ends are very peculiarly shaped, and the easiest way of ascertaining the average height is by developing the circumference of the end, measuring its area with planimeter or otherwise and dividing by the length of the developed surface. The illustration shows one half of the side developed, giving the area *b c*. The average height of this is found to be .276 as shown in the figures at the left of cut, which gives the answer, 32.173 cubic inches of brass removed.

* * *

A WORD TO THE WISE IS SUFFICIENT.

The following notice adorns the office of a well known engineering firm at 39 Cortlandt Street, New York, and will doubtless be appreciated by many other business firms:

NOTICE.

At a regular annual meeting of the Ruggles-Coles Engineering Co., held December 28, 1895, the following resolutions were unanimously adopted:

Whereas: The Ruggles-Coles Engineering Co. was organized in May, 1892, for the purpose of entertaining our friends, talking politics and religion, arguing with agents and advertising solicitors, keeping a haven for the Sons of Rest, and numerous other philanthropic objects and:

Whereas: The aforesaid objects have been attained beyond our most sanguine expectations, and being fully satisfied therewith, Therefore be it:

Resolved: That on and after Jan. 1, 1896, we effect a *Reorganization*, having the following objects in view, viz: Attending to our own business, letting Grover and the Pope run the affairs of State and the Church without further assistance from us, letting our friends amuse themselves and agents talk to themselves, allowing the Sons of Rest to find headquarters elsewhere without further objection, and in brief to make money for the Company, the members and stockholders thereof, their heirs and assignees forever, and:

Resolved: That a copy of these resolutions be posted, and our friends be requested to aid us in carrying out the aforesaid objects to the best of their ability.

WHAT MECHANICS THINK.

THIS COLUMN IS OPEN FOR THE EXPRESSION OF PRACTICAL IDEAS OF INTEREST, TECHNICAL OR OTHERWISE. WRITE ON ONE SIDE OF THE PAPER ONLY, AND BOIL IT DOWN.

WHEN SKETCHES ARE NECESSARY TO ILLUSTRATE THE IDEA, SEND THEM ALONG—NO MATTER HOW ROUGH THEY MAY BE, WE WILL SEE THAT THEY ARE PROPERLY REPRODUCED.

REPAIRING A TWELVE TON HOUSING.

While the following description of the way and manner in which heavy housing are repaired at the shops of L. Spence & Sons, Martin's Ferry, O., may be old to some, yet I believe there is a class of readers of this paper, especially those engaged in mill work and others, that it will interest. The A. S. I. & S. Co., which is close to the above shop, uses housing in their plant ranging from seven to twelve tons, costing anywhere from five hundred to a thousand dollars. It can readily be seen that any breakdown of one of those housing means heavy expense to the firm. By referring to Fig. 1, *d* is a place where the housing usually breaks. Fig. 2 represents one of these links when finished. There are two, one on each side of the broken part of the housing. They are shrunk into their places as shown by dotted lines, Fig. 1.

Fig. 3 represents two of the links after they have been planed off on their flat surfaces bolted together for the purpose of planing their edges alike. In the shop are found templates for the

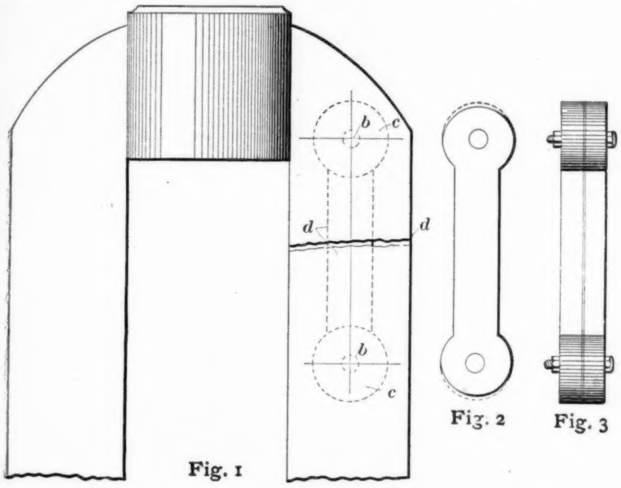


Fig. 1 Fig. 2 Fig. 3

different sized links. After a suitable place is located on the housing the template is laid on and marked off as shown. The same template is used to lay off the links. The holes *b b*, Fig. 1, are drilled through with a 2 inch drill. Then a 2 inch round bar with cutters, cuts *c c*, Fig. 1. to 9 inches in diameter and 2 inches deep, thickness of links. [These dimensions apply only to the twelve ton piece.] The space *d* which connects holes *c c* was drilled and chipped out to 5½ or 6 inches wide and 2 inches deep. All of the smaller sizes were planed out, but this one was too large for the planer. The links are planed just a little smaller so as to allow them to drop into their places when heated more so at the ends, as shown by dotted lines, Fig. 2. After they were heated and put into their places they were drawn up tight with two 2 inch bolts; the amount of draw given the links were governed by the amount of opening in the break. This manner of repairing has given good results; suffice to say that one or two of those same housings broke for the second time and it was on the opposite side. B. F. AULT.

Martin's Ferry, O.

WALLS FOR COLD STORAGE BUILDINGS.

Allow me to take exception to your advice to "K. T. T." for the construction of walls for a small cold storage building. Your design is only necessary in the very heaviest of buildings, six to ten floors; "K. T. T." wants walls for a small building. Now we have three buildings here which have paper insulation *principally*. The construction is about like this: 18 inch brick; 2×4 studding filled with mineral wool; ⅞ sheathing; four air spaces 1 inch thick on studs; 1×2 separating rosin-sized paper.

I recommend this: 2×6 studding against brick wall of sufficient strength for height of building, filled with planer shavings; ⅞ sheathing and six 1 inch air spaces, composed of rosin-sized paper above, ⅞ tight sheathing inside. Use hemlock all through, with six-penny box nails.

Your point of decomposition and maintenance is O. K., but considering first cost of construction, the construction I recommend could be replaced every eight to ten years, when interest on investment is carefully figured. I can guarantee my construction to give as good insulation as yours. MADISON COOPER, JR.

Minneapolis, Minn.

[Our information was obtained from one of the best known builders of refrigerating machines. If there is a cheaper construction which will give good results we are glad to know it, and as Mr. Cooper is superintendent of a refrigerating warehouse, his opinion is of value.—ED.]

ELECTRIC SUBMARINE BOATS.

"It is understood that the Electric Storage Battery Company, of Philadelphia, has contracted with the Government to supply two submarine boats with batteries providing sufficient power to propel the boats at a high rate of speed above and below the surface of the water. Every nation in the world is closely watching the possibilities of the electric motor, as the great weakness of the powerful sea machines which all navy departments are constructing, is the insufficiency of coal supply which the great war vessels can carry. Without coal they are useless. *If electricity can be substituted there will no longer be the necessary dependence upon coaling stations*, scattered over the entire surface of the globe."

Mr. Edditur:

Havin seen the abuv in a daly resently I wanter no if yu can get me a job on wun ov these nu botes. I've allus bin agin these cole combines an ef I can get a job where I doant hav to handle their blumin stuf I'll be happy.

Thes lectric botes will be grate—no cole tu shuvel, no steam to blo off and attract the nemy—guess we can lick anywun now—unless tha get sum two. What kinder gets me iz that whear I liv they hav dinamoze, which are run by a steme engin, to make ther lectricity with, but these botes doant need nuthin it seems cause tha wunt hav no colein stashuns nor nuthin.

Whear I am tha hav storage batries two but we hav to run a dinamow to fill em, but as this menes cole burned uv course tha must hav sum nu kind uv lectricity in these botes. The lectric launchez at the Wurlds Fare had to be charged at chargin stashuns (and then tha charged passengers to make up the cost) but as a lectric stashun is as much uv a noosance as a colein stashun I doant see how this iz much uv an impruvement, but az I said befor, this must be a nu kind of lectricity.

P'raps these botes hav sum kind uv a motor which just motes an keeps the batries full at the same time, or else hav first morgidge on ther lectric eels and other shockin things that rome the wet an watery deep. But before I get a job on these botes I'd like ter no how tha run, as I don't wanter get out at cee, chasing a briganteer or whatever yu call the other fellers botes, and hav the batries give out, with no lectric juice plant neer and the neerest eel given exhibishuns to the mermades a mile or so below. Can yu tell us the kind uv lectricity tha use ? W. E. HAWKEN.

Gloucester, N. J.

[Our correspondent asks too much; we can't tell him what the plans are, but we feel with him that it must be a new kind of electricity that can be stored and render a boat independent of coaling stations (or what is the same thing, power stations). The great trouble with daily papers, and many people who ought to know better, is that they seem to consider electricity a power of itself, instead of a means of transmission—in fact, it may be compared to a belt between the engine or power and the shop shafting, or work performed; the electricity is simply a means of transmitting mechanical or chemical energy into desirable forms. —ED.]

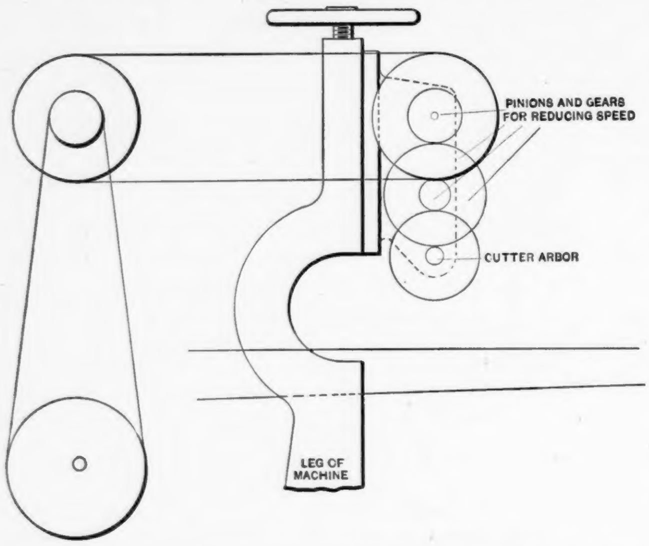
VIBRATION OF SHAFTS.

Will any of your readers, experienced in this line, give some information on the following question: If a pulley shaft vibrate a building at a certain speed (being in harmony with it at that speed or some multiple of it), how would you calculate the speed at which it would be out of harmony with the building so as not to shake it at all. How could the necessary speed *above* or *below* the normal be calculated ? S. W. F.

[We feel safe in saying that so many conditions enter into a problem of this kind that accurate calculations are decidedly difficult, to say the least; probably impossible would be nearer right. We print the inquiry, thinking that some who have had experience in the line may be induced to favor us with it.—ED.]

OLD MILLING MACHINES.

Being interested in your illustrated articles on old tools, especially milling machines, I send a sketch of the driving mechanism of some old milling machines in one of the Lowell machine



shops. The table is similar to that of a planer, the various driving pulleys and gears being arranged as shown. The cut explains itself, so will say no more. F. E. RATHBUN.

Lowell, Mass.

SCREW CUTTING.

Having hit upon a formula for shortening the amount of calculation required when finding the change gears for odd pitches of screw threads, and not having seen it in books or mechanical papers in this particular form, I concluded to send it to your paper, thinking it may be of interest. It can be applied to any kind of example which might come up, and although it may not be the shortest way in all cases, yet I think it is as short an all around formula as can be applied.

A represents the length in which threads are contained; B the number of threads per inch in lead screw of lathe; C the number of threads required in given length; $x : y ::$ stud gear : screw gear.

Then

$$\frac{AB}{C} = \frac{x}{y}$$

To explain this clearly I give two examples. Suppose it is required to make a screw of 5 threads in 1⅛ inches. The lead screw of lathe contains 6 threads per inch. Then substituting the figures in the formula

$$\frac{1\frac{1}{8} \times 6}{5} = \frac{9}{8} \times 6 \times \frac{1}{5} = \frac{27}{20} = \frac{x}{y}$$

and a gear of 27 teeth on the stud and 20 on the screw would be the gears required.

Again supposing we require to make a screw with a pitch of .333 with a lead screw on lathe of 6 threads per inch.

$$\frac{.333 \times 6}{1} = \frac{1.998}{1} = \text{nearly } \frac{2}{1}$$

and gears on the lathe in a proportion of two to one would be required.

If the fixed gearing of the lathe was such that the lead screw did not make the same number of revolutions as the spindle in a given time with equal gears on the stud and screw, the number of threads in lead screw would not be used in the formula, but the number of threads per inch that the two equal gears would make should be used instead. J. T. G.

GOOD MECHANICS—GOOD WAGES.

In your April number W. H. Chappell asks questions and makes statements with such recklessness and rapidity that a slow thinker like myself can hardly keep track of what he wishes to convey to the reader's mind. While not wishing to answer any of his questions and heartily agreeing with him that piece-work or something of that ilk is the panacea for lots of trouble, I would like to criticise a few of his statements. He says that it is a case of filling the shop with hoboes or going without help altogether. Very true if only hobo wages are paid in that shop. Good intelligent machinists are fairly plenty, and I am very happy to say the demand for these is fairly active. The case he cites where a two-fifty man was put to boring collars that an apprentice could bore and face at the rate of one every ten minutes, looks as if we had not heard the whole story. I once went to work in a shop where a new man was much handicapped by a habit the old hands had of hiding all the tools not in actual use. I was given planer work that special tools would have expedited; I found none so made what I wanted. I was slow on the first piece, but at the end of two weeks the foreman said to me: "We would like to make it an object for you to remain with us, and your wages will be advanced from to-day."

Now in the shop where an apprentice can bore and face twelve $2\frac{7}{16}$ collars in two hours, there is some attempt at special tools. It may not be much of an attempt or the output would be increased, and I doubt very much if the two-fifty man knew anything about that part of it. If Brother Chappell really wants to hire a few first-class machinists, men who were born mechanics, men who can turn and bore, plane and mill, chip and file, fit and scrape, whether the work be on steam pumps or type-setting machines, he can get them by simply paying the market rates. Just now all such men are working, and an ordinary ten cents a day raise will not catch a great number. I fear one cause of Mr. Chappell's trouble lies in the fact that he wants to get first-class men, men who are exceptional mechanics, for ordinary wages. He cannot do anything of the kind.

When it comes about that a news-stand, a cigar store, or a night lunch cart will pay a better dividend than time spent at the vise or drill-press, the shops will be filled with men who haven't the ability to run the cigar business; then men like Brother Chappell kick and good machinists laugh. F. S. JOHNSON.

Lynn, Mass.

MAKING THE CORE BOX.

The way in which the core-box was actually made will be clearly shown by the accompanying illustration. Fig. 1 shows the cross-section of the core-box through the overflow chamber, while Fig. 2 shows one-half the core-box laid open and one of the loose pieces in position. The cross-section, Fig. 1, shows the pieces in position, and from Fig. 2 it can be seen that they fitted into a little ledge in the core box. They were put in place, the sand rammed around the loose pieces (core wires being first put

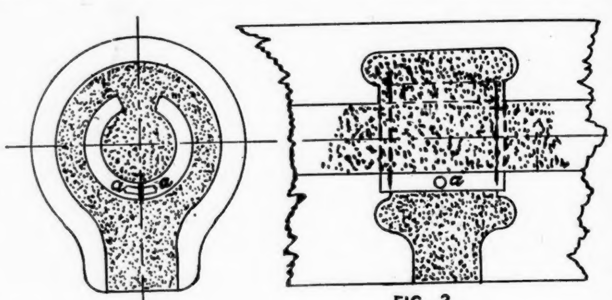


FIG. 1 FIG. 2

in place), and after both sides are ready they are covered with core wash in the usual manner. Just before putting the box together, a wire is inserted in the small holes in the loose pieces and the pieces deftly withdrawn, after which the two halves of the box are put together. This leaves the opening by the loose pieces for the flowing of metal, and the overflow chamber is formed. This was devised about ten years ago, and many hundred have since been cast, although the loose piece is scarcely more than one-eighth of an inch.

Camden, N. J. R. E. MARKS.

AMENDMENTS TO "HINTS FOR YOUNG DRAFTSMEN" IN THE MARCH ISSUE.

1. In making sketches be sure to put on correct dimensions. In making drawings ("sketches to a scale") have all parts scale accurately and correct dimensions plainly written down.

2. In drawing with ink see that your pen is in a good condition and that the ink which you have to use is quite black and of good quality.

3. When it comes to inking in drawings let your left hand manage the tee-square and triangles, and let your right hand manage the pen. Press lightly on the tee-square and triangles to keep them in position, but do not press the pen on the paper, let it slide as freely as you can. When you have decided on the thickness of the lines, do not touch the adjusting screw any more. Keep your pen in one position through all your work.

4. Draw all circles first, then all curved lines, and afterwards proceed to the straight lines.

5. When you have advanced so far ask your boss, if you have not done it before, how he wants the center lines and dimension lines to be drawn, and draw them accordingly. If you have no boss, please yourself. You can make them either black, red, blue, brown or any other color you may choose. Always make some difference between center lines and dimension lines. If you choose the black, make the lines thinner than those of the drawing. A commonly adopted way and one which shows well on a blue print, is to make the center lines either one continuous, straight, thin line, or thus: —— - - —— - - —— - - and the dimension line thus: —— - —— - —— - —— - .

6. When making a drawing from a sketch, tracing or some other drawing, be sure not only to understand what every line represents, but to get *all* the necessary information, otherwise you may be sure to make some mistake, though you know what the lines represent.

7. If you intend to study the theory of the steam engine, do not forget the valves. In fact do not forget anything, but take it all up in proper order.

8. In doing this you will also come to the indicator. Learn to understand this instrument and to understand the diagram or card made by this instrument, through the action of steam in it. Learn also to figure the horse power from it. To understand the instrument common intellect is required only, and you can learn it at any time. To learn to figure the horse power from a diagram is required some knowledge of algebra and geometry and to make other computations therefrom, and to understand it otherwise is required a thorough knowledge of steam and its distribution in the various cylinders of an engine; therefore study this first.

9. As most steam engineering of to-day is connected with electricity, read up on electricity. CONRAD SKARSTEDT.

Chicago, Ill.

IRON AND STEEL.

In your June number you publish an article on iron and steel, by Mr. Hood, which I have read with considerable interest, as I do your publication generally.

Quoting from his article he states we have three forms of steel, viz., natural steel, shear steel, and cast steel; then again he states that natural steel is made from wrought iron by heating for several hours with charcoal, which increases the amount of carbon, therefore converting it into steel, but steel made in this manner is very inferior to either shear or cast steel.

In this proposition I think Mr. Hood is in error. What he calls natural steel I presume would be blister steel, which is made as he states, by heating wrought iron with charcoal for a number of days, thus converting it into steel. This blister steel is the basis from which both shear steel and cast steel is made, and until the invention of the Bessemer and similar processes, was the manner in which all steel was made. Take this blister steel, and by rolling we make spring steel; by hammering this same blister steel we make shear steel; by breaking up this same blister steel, casting it into ingots and then hammering these ingots out, we have cast steel, all being the product of the original blister steel.

I submit this for what it may be worth, thinking the part of Mr. Hoods article referred to is not correct in its conclusion.

Dallas, Texas. JOHN G. HUNTER.

* * *

MACHINE DESIGN.

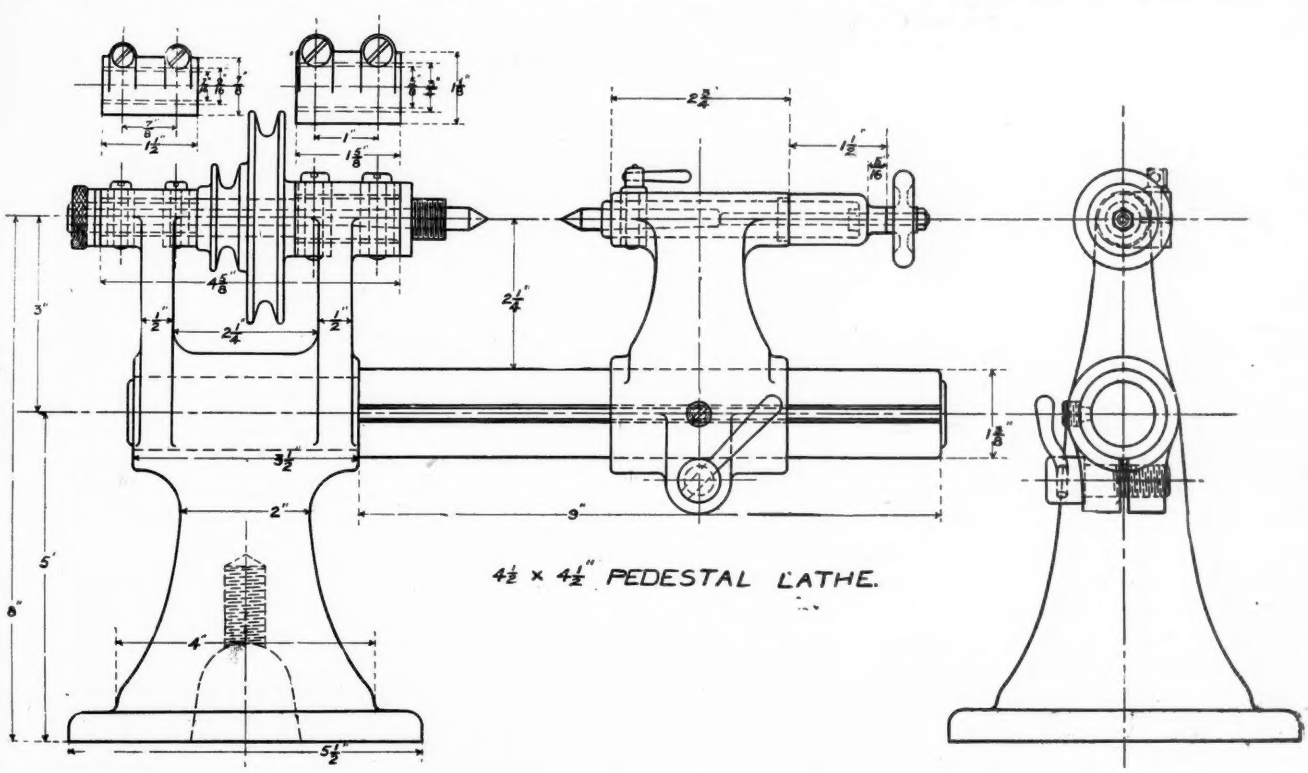
F. W. CLOUGH.

This is the general outline of a small bench lathe, designed by the author years ago, intended for watch and similar small work. Two were built from this design and pattern, and on account of their rigidness gave good satisfaction.

The head and pedestal are one casting, neatly finished all over; the live spindle runs in bronze bushed bearings clamped into head uprights; both the head hubs and bushes are cut open and the recess filled with a strip of pine wood, onto which the clamp screws pinch the hub and bushings when bearing and spindle runs tight, but free.

The bed of lathe is a piece of tool steel turned and ground to a correct and uniform diameter and fitted solidly into pedestal head, the foot of stock has two holes, one to fit bed the other to receive the dead spindle. To obtain exact alignment of live and dead spindles, the holes in head to receive bronze bearings and the hole in foot-stock to receive dead spindle were bored on a true face-plate, on which was located a true pin which fitted the larger hole of head and foot-stock; and in bed on front side is placed a taper groove into which locating pin on foot-stock is screwed, the foot-stock well clamped to bed by a split hub and clamp screw. The slide rest and an ordinary hand tool rest were clamped to bed in the same manner as the foot-stock.

This lathe has done some excellent work, and on account of its rigidity turns work remarkably smooth. The slide rest and hand tool rest are not shown in cut.

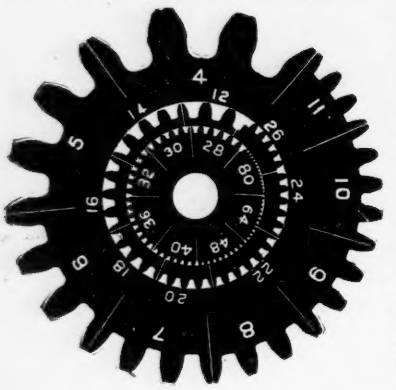


4½ × 4½" PEDESTAL LATHE.

THERE are many shop kinks and good ideas lying idle in almost any shop which would help some one else in their daily hustle for bread and a few dollars extra. No one would be the loser by having them made public and other shops would add to their stock in trade by knowing these kinks. It isn't necessary to have gilt-edged drawings; sketches can be used if they are clear, as our engraver is sort of a mind-reader. Better tell us how you "rigged up" for that last job.

GEAR GAUGES.

Every machinist will appreciate the necessity of wire, twist drill, sheet steel and other gauges. As gears are made or ordered very frequently and form an important part of most machines, it is obvious that a set of gear gauges that can be readily used would fill a long felt want. The gauges are designed for many purposes. A gear cut a certain pitch, if cut correctly, will mesh nicely with the corresponding pitch marked on the gauge. If it does not mesh correctly it will indicate that the gear is spaced wrong or cut to some odd pitch, which for fine pitch is not in general use. Those who do not cut gears frequently will not know by sight the exact depth a space should be cut. By placing the gauge on the blank to be cut, the exact depth and width can be easily scratched on same. The gauges are very useful to draftsmen for drawing tooth outlines. For this class of work we advise using a set with teeth a trifle thin to allow for the thickness of the pen or pencil used, otherwise the teeth will be marked thicker than the gauge. Manufacturers designing new movements will find it quite helpful to have gear gauges of all available pitches at hand, as the exact size can be comprehended better than from a mere print or sketch. Boston Gear Works, 40 Hartford Street, Boston, Mass.—*Adv.*



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MANUFACTURERS' NOTES.

MESSRS. CHAS. CHURCHILL & CO., Ltd., the well known dealers in American machinery, expect to be located in larger quarters on July 1st, at 9 to 15 Leonard street, Finsbury, London, E. C.

THE UTICA DROP FORGE AND TOOL CO., Utica, N. Y., are now manufacturing a complete line of nippers and pliers; the Hall nipper patents being owned by them. Mr. Fred C. McClary is superintendent and H. Laurence White assistant superintendent.

THE NEWTON MACHINE TOOL WORKS, Philadelphia, Pa., have received a large order from the new Russian Locomotive Works, included in which are many heavy milling machines, cold saw cutting-off machines, boring machines, etc.

THE Kempsmith Milling Machine Co., Milwaukee, Wis., are very busy on a lot of special machinery for the Elgin National Watch Co., Elgin, Ill.

THE Goulds Mfg. Co., Seneca Falls, N. Y., the well-known pump builders are compelled to run their power pump department night and day to prevent falling too far behind their orders.

MR. NORMAN H. FAY has purchased the entire interest of Mr. Scott, in the firm of Fay & Scott, Dexter, Maine, and will continue the business under the old name.

WE have received a fine half-tone of the Imperial Russian yacht *Standart* from Jenkins Bros., New York City, together with a fac-simile letter from their Copenhagen representative, Gustav Halberstadt, with the information that he had placed several hundred Jenkins's valves on the yacht.

* * *

BUSINESS.

NO CHARGE IS MADE FOR THE INSERTION OF BONA FIDE ITEMS UNDER THE ABOVE HEAD. FOR FURTHER PARTICULARS, ADDRESS THIS OFFICE.

WE have an inquiry for a "wash" to be used on steel cores so as to produce good holes in castings.

WE have an inquiry for a maker of lathes or chucks which will turn ovals or ellipses from ⅛ inch to 3 inches long diameter.

* * *

FRESH FROM THE PRESS.

"*Compressed Air.*" Monthly. 16 to 20 pages, 5¾x8½ inches. 26 Cortlandt Street, New York. $1.00 per year.

This little paper is devoted to the useful application of compressed air. Mr. W. L. Saunders is the editor and publisher with A. E. Kenney as managing editor. There is certainly a field for this publication, as the widening uses of compressed air seem to warrant a paper devoted exclusively to it.

"*Press Working of Metals.*" Oberlin Smith. John Wiley & Sons, New York. 276 pages. 433 engravings. Price, $3.00.

The author's long connection with the building of presses for nearly all classes of work at once calls attention to the book and one is not disappointed. It deals with a subject which, though largely used in modern manufacturing, has had little written on it and which is extremely interesting, both from its clear treatment and the value of the information. No review can do justice to such a work, it must be seen by the mechanic to be appreciated, and any one who uses presses or wishes to become familiar with them will find the book of valuable assistance.

"*Gas Engines.*" G. Lieckfeld, C. E. Translated by George Richmond, M. E. Spon & Chamberlain, 12 Cortlandt Street, New York. 103 pages. Price, $1.00

This is the latest of Spon & Chamberlain's handbooks and is a timely publication, as it deals with a subject which is of growing importance. The book treats of the construction, workmanship, running, economy, reliability and durability, cost of installation, erecting, foundation, arrangements for gas pipes, and has, in fact, more information on gas engines than it seems possible to get into a book of the size. It explains about running, detecting faults and remedying them, and will be invaluable to men handling gas engines. The information regarding oil engines in the book is alone worth the price.

"*Electric Lighting. Vol. 1. The Generating Plant.* Francis B. Crocker, E. M., Ph.D. D. Van Nostrand Co. New York. 444 pages, Price, $3.00.

This is the first volume of what promises to be one of the leading works in electrical engineering from a practical point of view. The author is well-known for his practical work in this line, and in the present volume he gives just the information that many have been seeking. After a brief historical chapter he deals with the station, boilers, engines of various kinds, water wheels and windmills, methods of driving dynamos, principles and construction of dynamos, their management, accumulators, etc., in his usual pleasing style. The book should have a wide sale.

"*Discipline Without Suspension.*" Geo. R. Brown, General Superintendent Fall Brook Railroad. Locomotive Engineering, New York. 8 pages, 6x9 inches. Price, 10 cents.

This is a reprint of an article in Locomotive Engineering which has attracted widespread attention, and which should be carefully read by everyone having employees under their charge, as it presents the most humane system of maintaining discipline that we know of. As this is from the General Superintendent of a road with 257 miles of single track, with an average tonnage of about 6,000,000 tons, and which has been in operation for the past twelve years, it can hardly be called visionary. We wish all shop and railroad managers would give it their careful attention.

"*Alden's Living Topics Cyclopedia.*" John A. Alden, 10 Vandewater street, New York. Price, $1.00.

The first volume is of very handy size, containing probably 300 pages (they are not numbered), and taking us well into the C's. It contains the latest information about Brazil, British Empire, Cape Colony, Chile, Chinese Empire, etc., etc. It is extremely handy to have the recent happenings at hand in a compact form, and it is found in no other work that we know of.

* * *

ADVERTISING LITERATURE.

THE STANDARD SIZES FOR CATALOGS ARE 9X12, 6X9 AND 3½X6 INCHES. THE 6X9 IS RECOMMENDED, AS THIS SIZE IS MOST LIKELY TO BE PRESERVED.

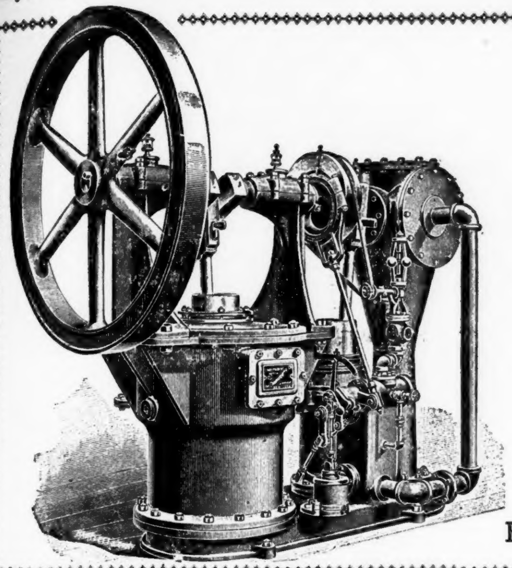
"*Ventilation and Heating.*" B. F. Sturtevant Co., Boston, Mass. 169 pages, 6¾x9 inches.

This is a treatise on the principles and application of the Sturtevant System, but while issued in the interests of this house, it contains information enough to warrant its being classed as a technical book. Besides much interesting data, there are several diagrams of buildings, showing the methods employed in heating and ventilating them. Considered as a book, it is a valuable addition to any engineer's library and as a catalog, we know of nothing in this line which can equal it. It is very carefully written and may be taken as an authority on the subject, being the work of Walter B. Snow, M. E., who is not unknown to our readers.

How Some $$$ were Saved: A little flyer from the pen of Walter Lee Cheney, Meriden, Conn., which shows, with few words and very expressive illustrations, the advantages of the double spindle lathe made by J. J. McCabe, 14 Dey street, New York, for job work where blocking up is ordinarily required.

"*Health and Pleasure*" again comes to hand with 532 printed pages, to say nothing of the numerous maps, folding and otherwise, which make it such a valuable book for all who are thinking of traveling long or short distances on vacations or business, or a happy combination of both. Any one having a little leisure (and the necessary root of all evil) can not only choose a delightful and inexpensive vacation, but can obtain all necessary information before starting. Even the stay-at-homes will find much to please and interest them, as the book is finely illustrated and the descriptions of the various places are very entertaining. The book can be obtained by sending 25 cents to George H. Daniels, G. P. A. New York Central Railroad, Grand Central Depot, New York.

"*Chestnuts*" is the name of a little booklet calling attention to the fact that "quality is always the first consideration" with the Kempsmith Machine Tool Co., of Milwaukee, Wis. Although no author's



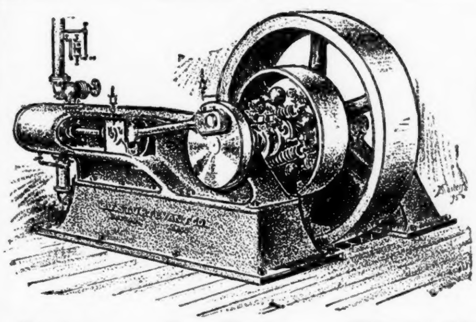
Conover Condensors.

Belt and Steam Driven.

The Conover Manufacturing Co.,

New York.

Havemeyer Building. 26 Cortlandt Street.



Sturtevant High-speed Automatic Engines.

B. F. STURTEVANT CO.,

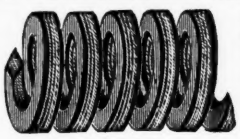
Boston, New York, Philadelphia, Chicago, London.

Chesterton's Square Flax Packing.

This brand is made of the **best** and **longest fibred Archangel flax** that can be purchased. It is perfectly lubricated and great care taken to make it a first-class article in every respect.

A. W. Chesterton & Co.,

49 India St. Boston, Mass.



Made to stand high temperatures, thoroughly lubricated and frictionless.

Let us send you a small order.

A. W. CHESTERTON & CO.,

49 India Street, BOSTON, MASS.

MONARCH BRAND SPIRAL PACKING

The Worthington Self-Cooling Condenser

Produces Vacuum Without Natural Water Supply

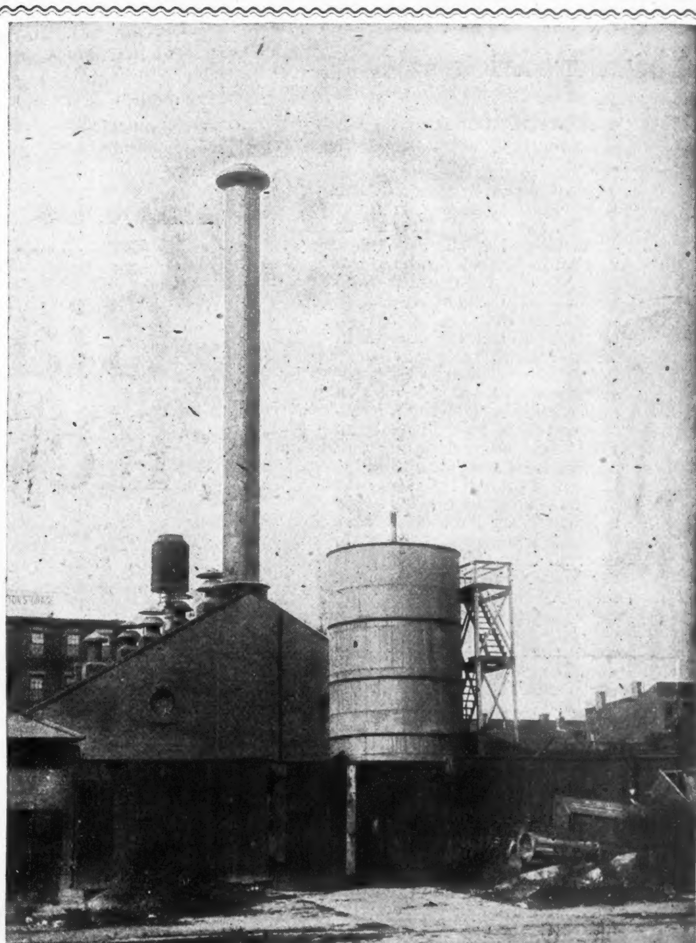
Requires No More Water Than That Used to Feed the Boilers

Results Guaranteed

SEND FOR CATALOGUE

Henry R. Worthington

New York



name is given, we venture to guess that it is the work of W. L. Cheney, Meriden, Conn.

CURTIS & CURTIS, 8 Garden Street, Bridgeport, Conn. Pipe Cutting and Threading Machinery. 44 pages, 8¼x9½ inches.

The well-known Forbes die stocks as well as the other machines and appliances made by this company need no description. They have been improved in some ways and are better than ever. One of the handy small tools is the nipple holder which, though not new, is decidedly useful in any shop.

W. F. & JOHN BARNES Co., 231 Ruby Street, Rockford, Ill. Catalog Woodworking Machinery. 40 pages, 6x9 inches.

This is uniform with the metal working machinery catalog mentioned last month, and shows foot power machinery for completely fitting out a workshop. Circular sawing machines, with their varied attachments and uses, are shown in variety, as well as combination machines. Mortising machines, whose usefulness in pattern work is too often overlooked, scroll saws and small pattern lathes are also shown, while circular saws and arbors, and a large variety of small tools complete the list.

THE FRANK H. CLEMENT Co., Rochester, N. Y. Catalog Wood Working Machinery. 9x12 inches.

This is a very substantial and attractive catalog, showing an extensive line of machinery that will interest the woodworker, and many that can be used to advantage in the pattern shop. The list includes surfacers, jointers, band-saws, bench saws, dovetailers, sanding machines, borers, lathes, etc., etc. It should be preserved for reference.

BROWN & SHARPE MFG. Co., Providence, R. I.

No. 1 Building Extension. A pamphlet showing the construction of their extension as well as the method of distributing power now in use in their work. This consists in belting direct from engine to main jack shafts, four belts running from flywheel. Binders are used in the manner illustrated in our February issue and give entire satisfaction.

B. F. STURTEVANT & Co., Boston, Mass.

A catalog of 54 pages, showing the various styles of forges made by this company, with numerous half-tones of shops using them extensively. They are adapted to a large variety of uses, as shown by the catalog.

THE CLARENCE E. VAN AUKEN Co., 166 South Clinton Street, Chicago, Ill. Steam Specialties. 40 pages, 6x9 inches.

This contains quite a list of Clevauc steam specialties, including pressure regulators, water columns, pump governors, air valves, etc., etc. It is nicely printed and the illustrations clearly indicate the construction and uses of the articles.

THE LEHIGH UNIVERSITY, Bethlehem, Pa., has issued a series of pamphlets giving a prospectus of the studies in the different branches. The departments especially interesting to mechanics will be Mechanical Engineering which, under the direction of Prof. J. F. Klein, embraces a very complete course. Civil Engineering, under the direction of Prof. Mansfield Merriman, is also interesting, as his work on strength of materials has endeared him to all mechanics.

THE ASHTON VALVE COMPANY, 271 Franklin Street, Boston, Mass., have issued an 80 page catalog, standard size, which contains a fine portrait of Mr. Henry G. Ashton, the founder of the company. The various styles of safety valves, mufflers and steam gauges are shown and described. Ammonia gauges, hydraulic gauges, gauges which give water pressure in pounds and height of column in feet; pressure and vacuum gauges, pyrometer gauges, showing steam pressure and corresponding temperature are among the specialties.

THE WESTINGHOUSE MACHINE Co., Pittsburg, Pa., send us a little booklet called "Something About Westinghouse Engines," which deals with the materials used in the construction of their engines and the class of work which is done in their shops. The materials employed are said to be from 25 to 30 per cent. above the government requirements. The system of inspection is also mentioned and our friend J. B. Thomas is shown at his work, with micrometer in hand, and the results of this rigid inspection is made apparent in the work.

* * *

MACHINERY'S REGISTER.

Any employer or shop manager who is in need of efficient assistance, either in the form of a superintendent, draftsman, foreman or machinist, can be supplied with the names of the kind of men they need, from our Register. We will mail names of five men, with their qualifications and references, of the kind desired, on receipt of four cents in stamps to cover postage.

SITUATION WANTED.—Experienced man, age 36, at designing and constructing; first-class draftsman, well posted in modern methods, at present assistant superintendent of a large manufacturing plant, would like to make a change. Will give first-class references as to ability and standing. Is willing to go South.
Address, "Expert," care MACHINERY, 411-413 Pearl St., New York.

AMBITIOUS YOUNG MECHANICS WANTED.—We are dividing the country into sections, each one of which we intend placing in charge of an energetic young mechanic (salary and commission) on circulation work and to gather shop notes for MACHINERY. There is valuable experience and information as well as money in this work; for energetic young men with the faculty for this kind of employment make from $15.00 to $25.00 a week, according to their ability. Some men cannot make $10.00 a week; others sometimes make $50.00; it depends on the man, not on the paper—that is all right. One of our representatives took over 700 subscriptions in about three months; another over 500; while there are scores of cases where from 25 to 100 have been taken in a week. Don't confuse this work with ordinary canvassing—it's as different as day is from night. If you want the representation for your State, write NOW; it may be too late next week, for nearly every day a section is given out.

See page 312 for the experience of one of our representatives.

Address, MACHINERY, 411-413 Pearl St., New York.

About Booklets and Catalogues.

TO bring out the best points of a tool or machine, the man who describes it must know what he is writing about—in fact he should be a mechanic himself. There are plenty of mechanics who understand the necessary points, but they can't put them on paper so that the other men will see them.

A knowledge of typographical effect is also a necessity in producing a booklet or catalogue. One man may see the good points of a machine and another may know how to put them into English; and in having the matter set in type both may miss the very effect it is necessary to obtain in order that the printed matter should produce the best results.

We have in this office a combination of the knowledge necessary. We can take the detail drawings of a machine, the phraseology of its builder, and without further assistance produce a booklet or catalogue *which will sell it, if it can be sold.*

That is, we write the description, make the necessary engravings, put the matter in type and submit you a proof. We print, bind and deliver the finished work to you at no greater expense than the same class of work can be done for anywhere.

If you are interested, write us.

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